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(54) **BONE CUTTING APPARATUS**

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A61F 5/00 (2006.01)

(52) **U.S. Cl.** **606/86 R; 606/87; 606/79**

(58) **Field of Classification Search** **606/86-89, 606/86 R, 79; 623/20.14, 20.34**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

- 5,021,055 A * 6/1991 Burkinshaw et al. 606/82
- 5,047,032 A 9/1991 Jellicoe
- 5,047,033 A 9/1991 Fallin
- 5,053,037 A * 10/1991 Lackey 606/79
- 5,304,181 A 4/1994 Caspari et al.
- 5,364,401 A * 11/1994 Ferrante et al. 606/84
- 5,415,662 A 5/1995 Ferrante et al.

- 5,496,324 A 3/1996 Barnes
- 5,591,207 A 1/1997 Coleman
- 5,593,411 A 1/1997 Stalcup et al.
- 5,653,714 A 8/1997 Dietz et al.
- 5,735,856 A * 4/1998 McCue et al. 606/87
- 5,769,854 A 6/1998 Bastian et al.
- 5,810,829 A * 9/1998 Elliott et al. 606/80
- 5,885,296 A * 3/1999 Masini 606/86 R
- 5,916,221 A 6/1999 Hodorek et al.
- 5,935,132 A 8/1999 Bettuchi et al.

(Continued)

FOREIGN PATENT DOCUMENTS

DE 203 03 643 7/2003

Primary Examiner—Thomas C Barrett

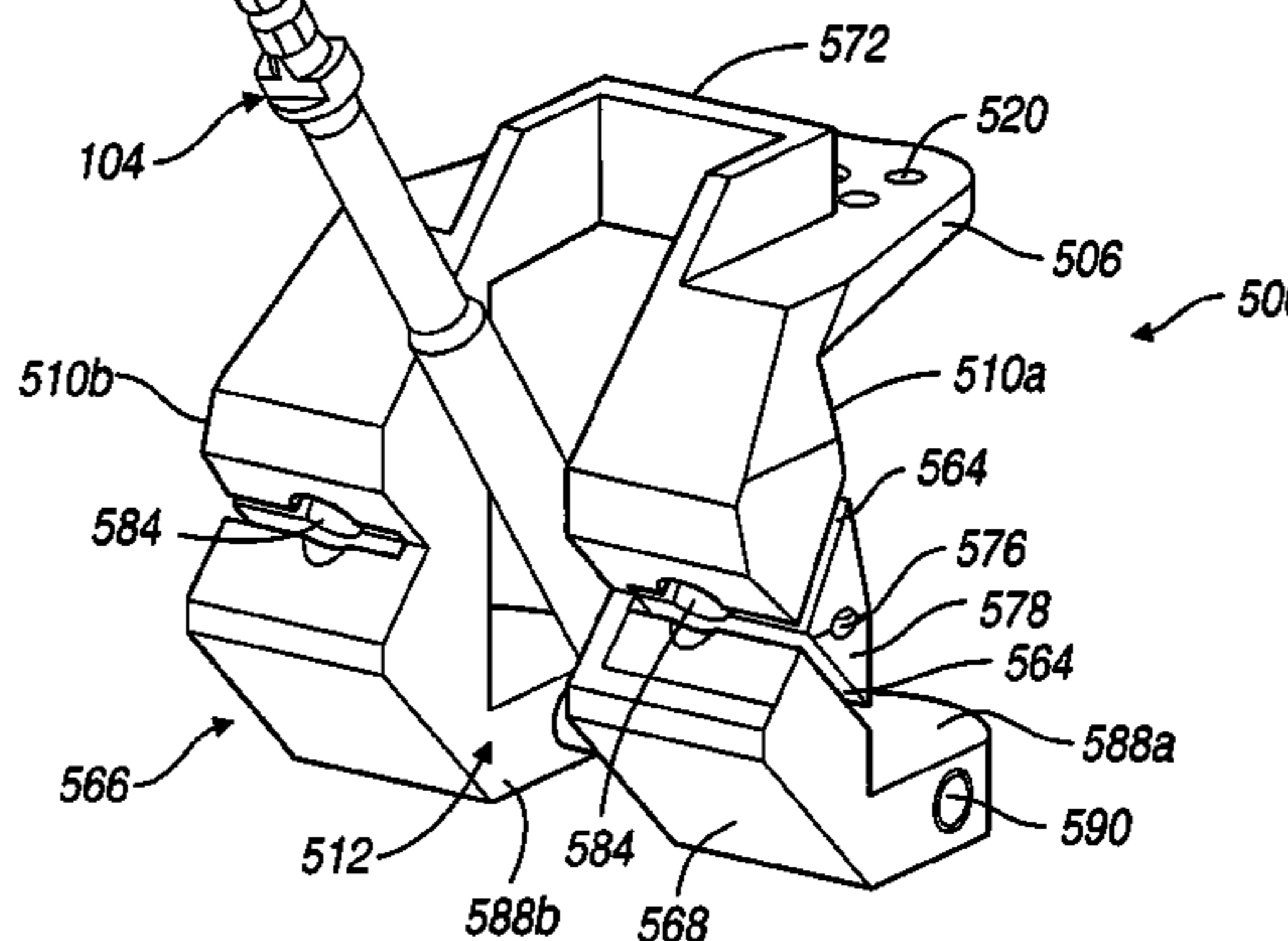
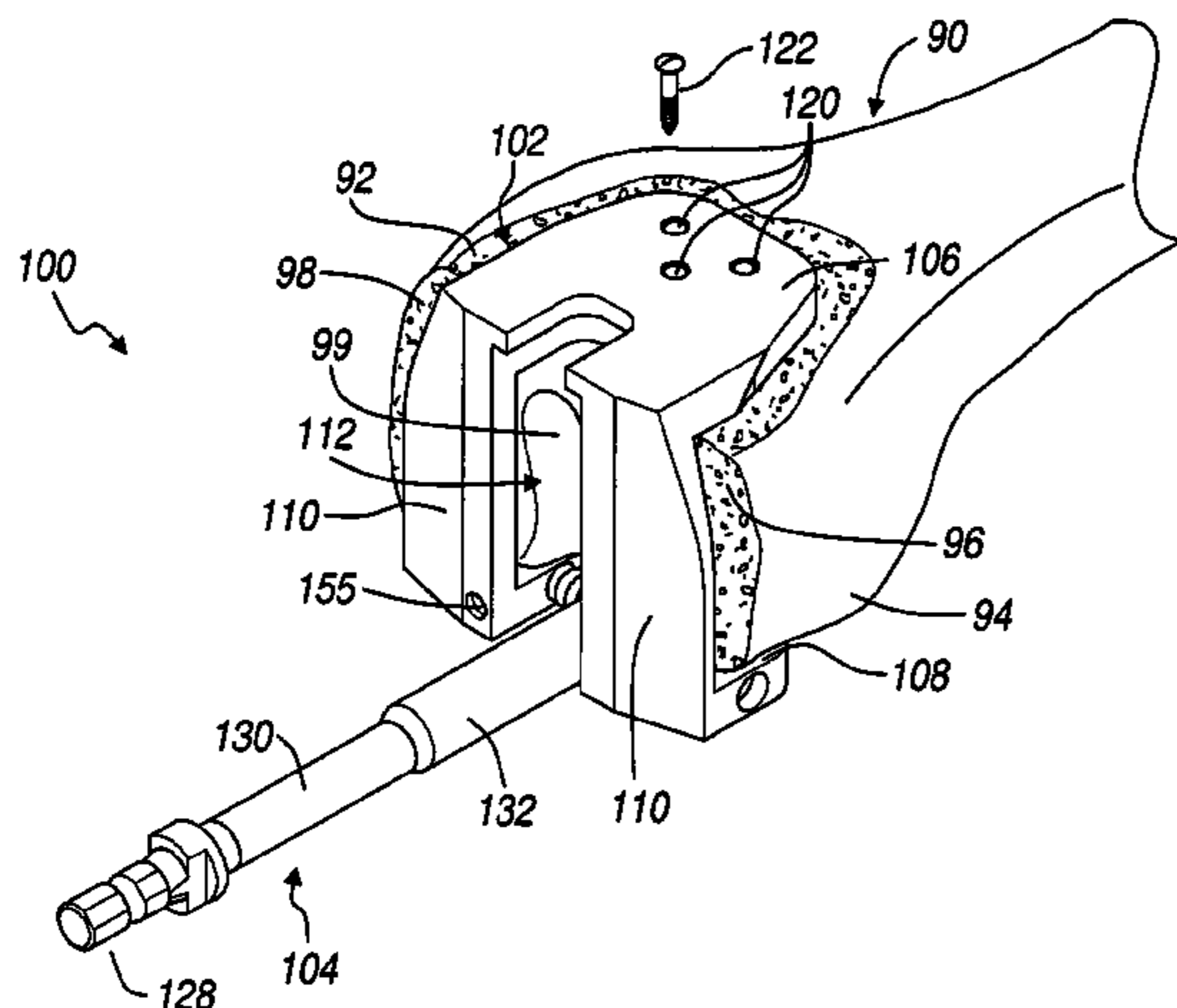
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(57) **ABSTRACT**

A guide for cutting a bone comprising an anterior portion and a distal portion orientated at about a right angle to the anterior portion. The distal portion includes a guiding side, a distal surface at the guiding side, a box-cut shaped opening defined by the guiding side, a plurality of first cutting surfaces disposed at the guiding side at an acute angle relative to the distal surface of the guiding side operable to guide a cutting device to the bone to form chamfer cuts in the bone, and a second cutting surface disposed at the guiding side at at least about a right angle to the distal surface operable to guide a cutting device to the bone to form a posterior cut in the bone.

20 Claims, 14 Drawing Sheets



US 7,674,268 B2

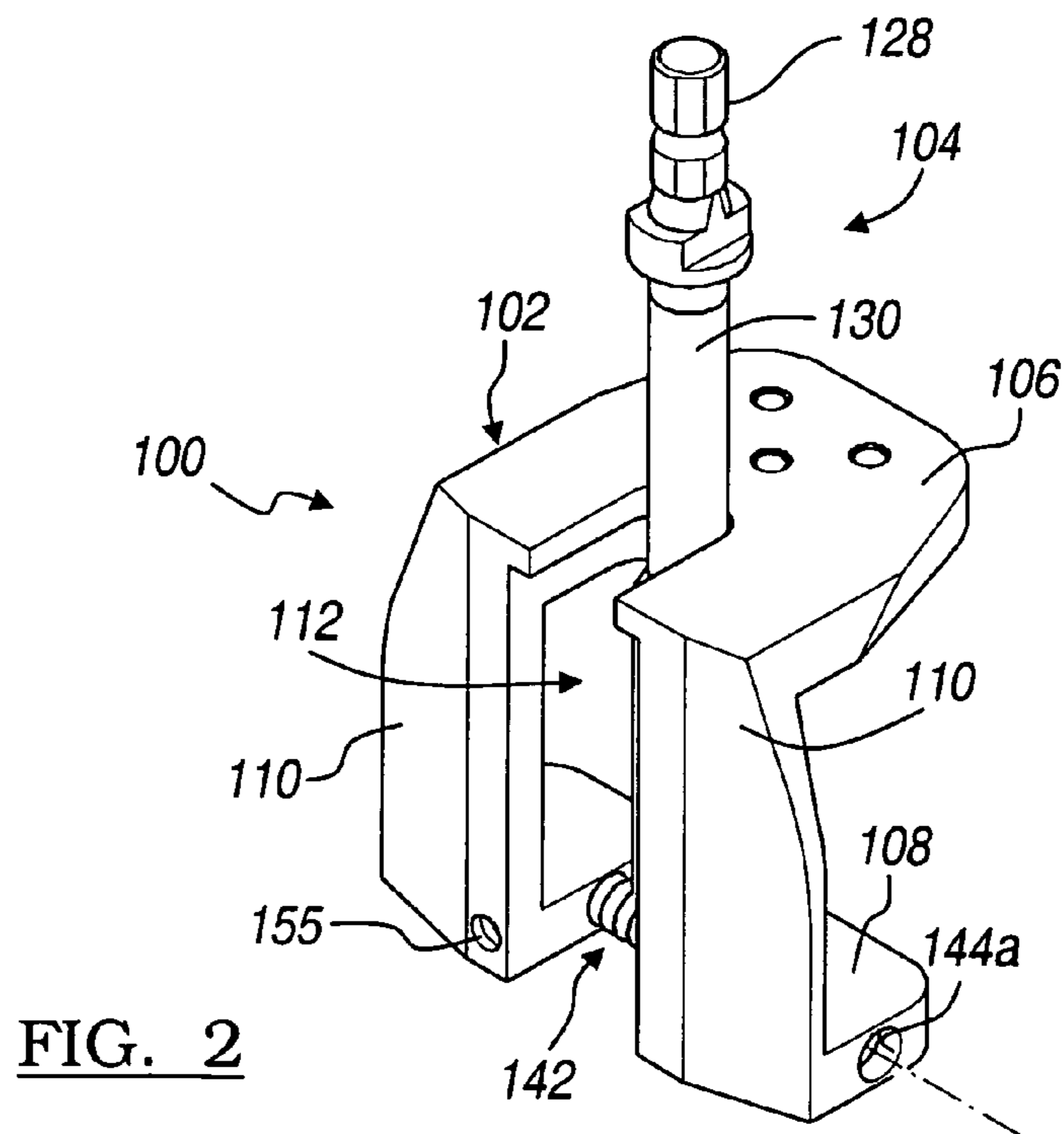
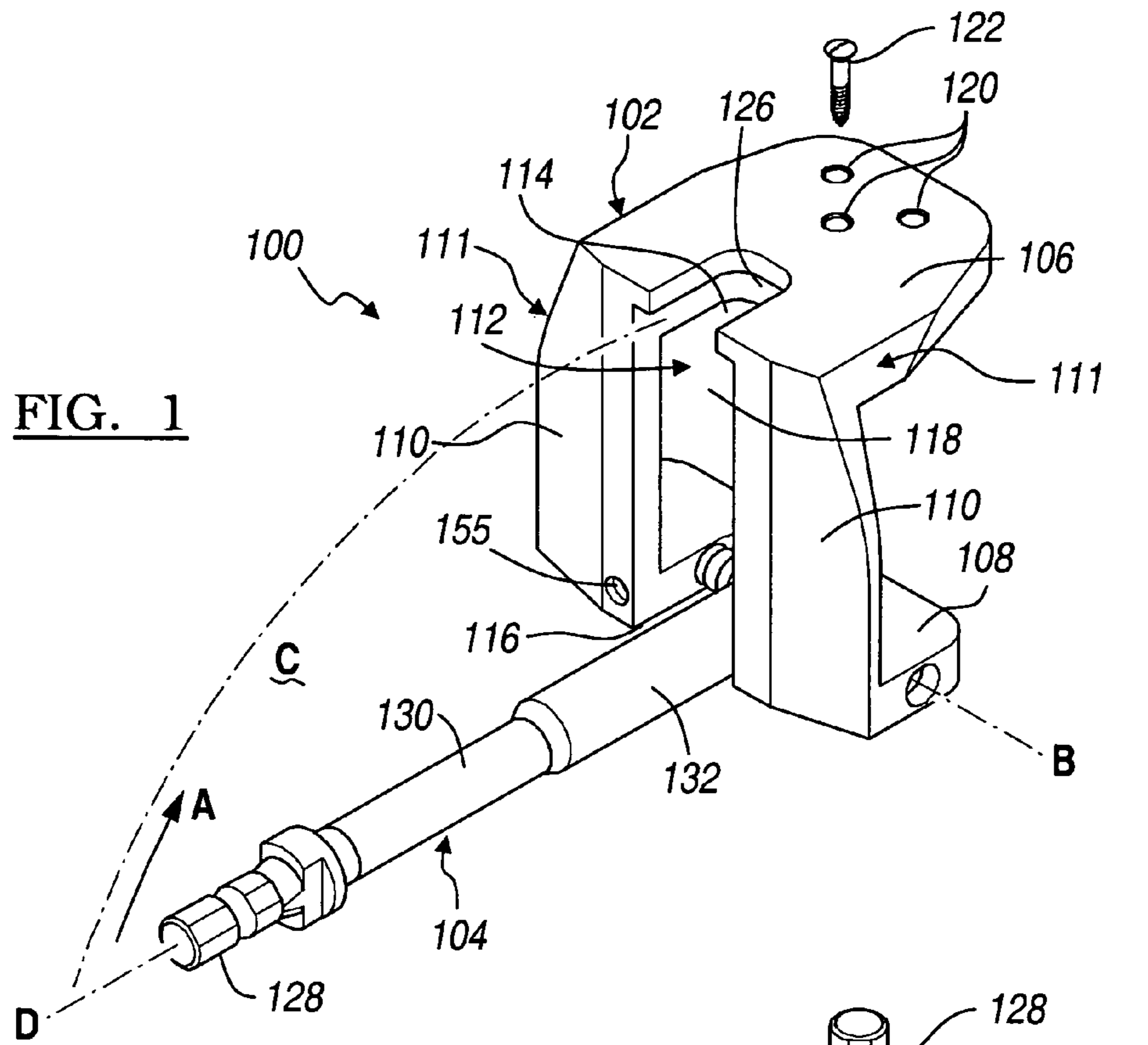
Page 2

U.S. PATENT DOCUMENTS

5,957,925 A 9/1999 Cook et al.
6,106,292 A 8/2000 Hollander et al.

6,258,095 B1 7/2001 Lombardo et al.
6,702,821 B2 3/2004 Bonutti

* cited by examiner



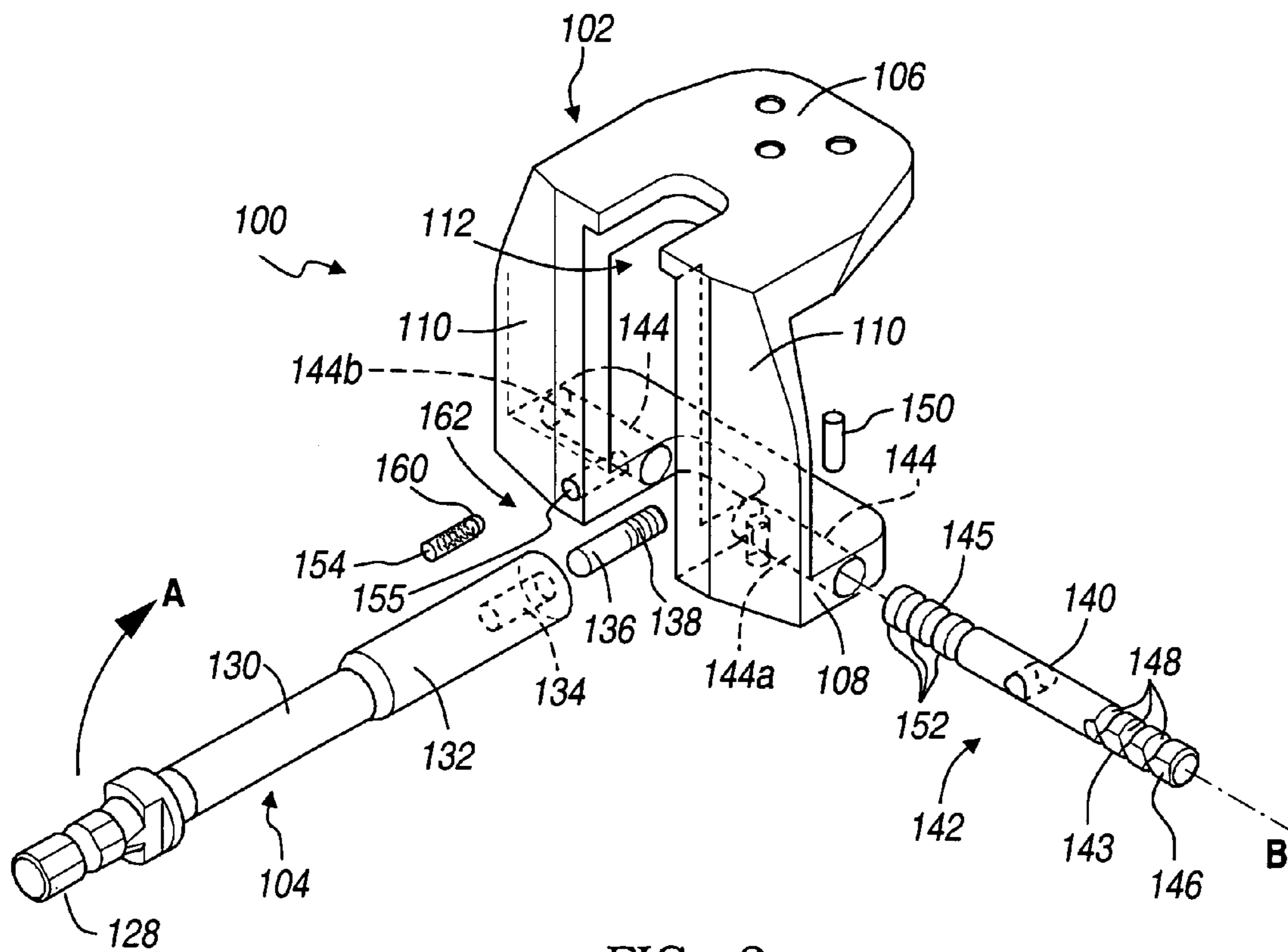


FIG. 3

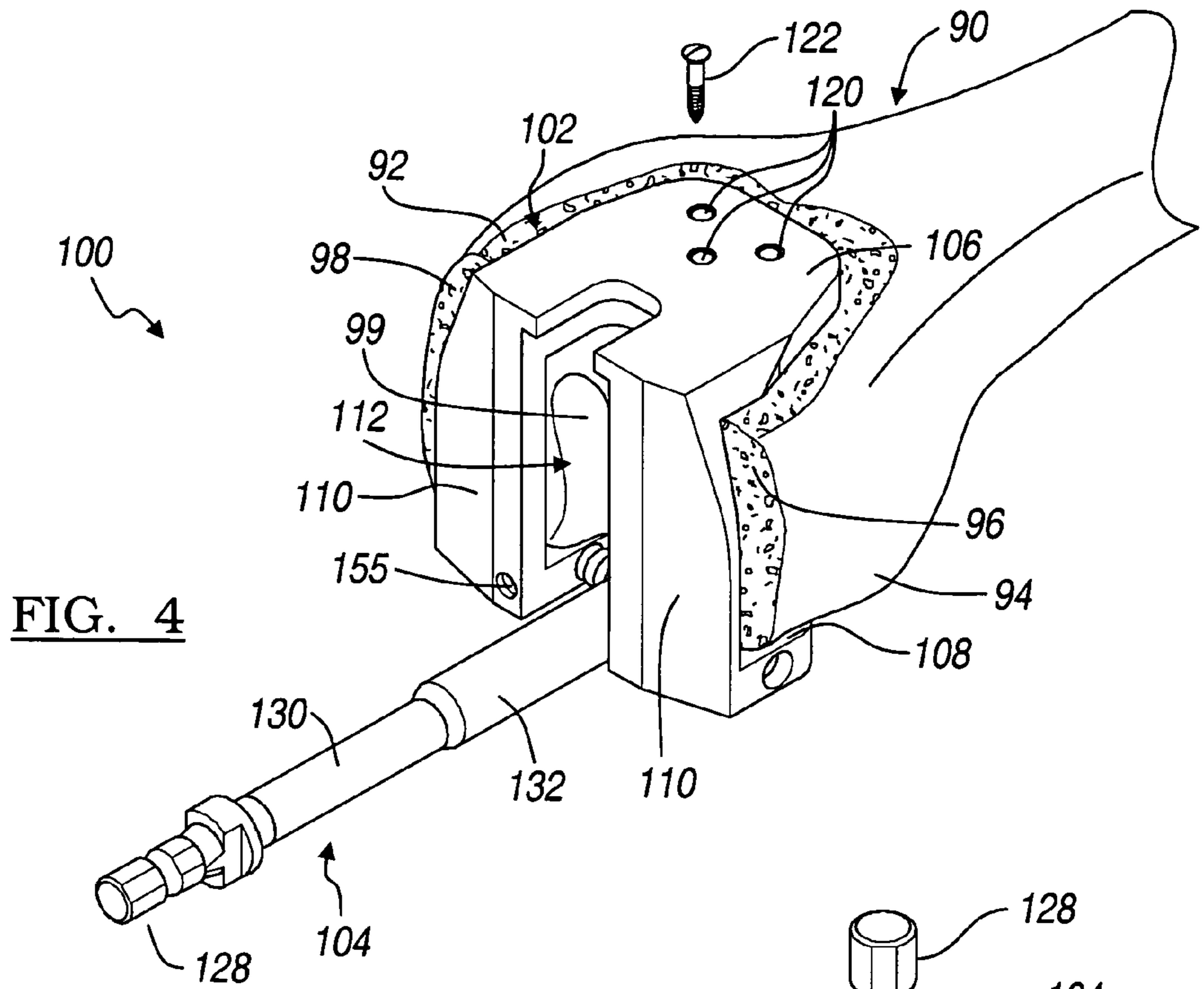


FIG. 4

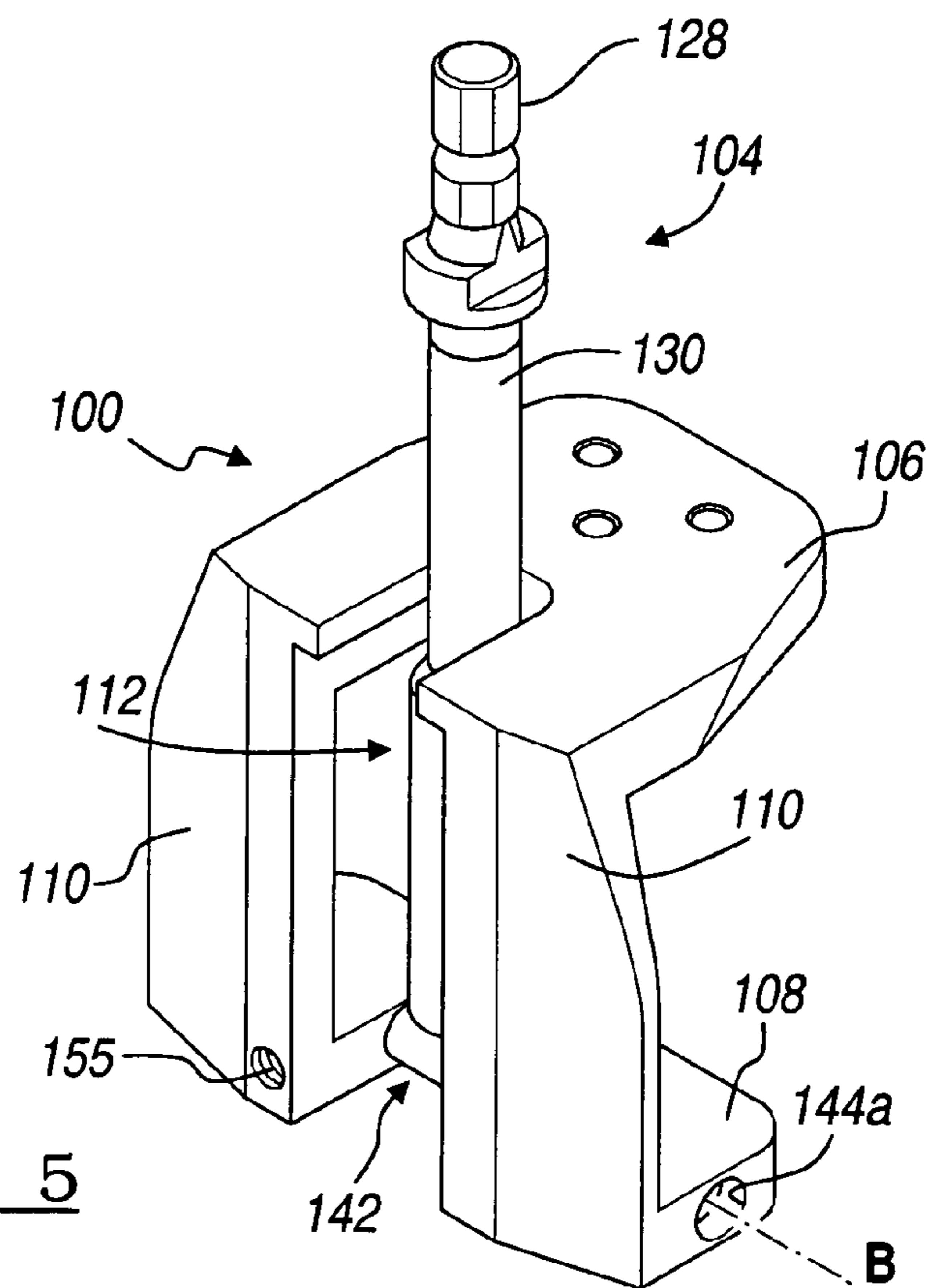


FIG. 5

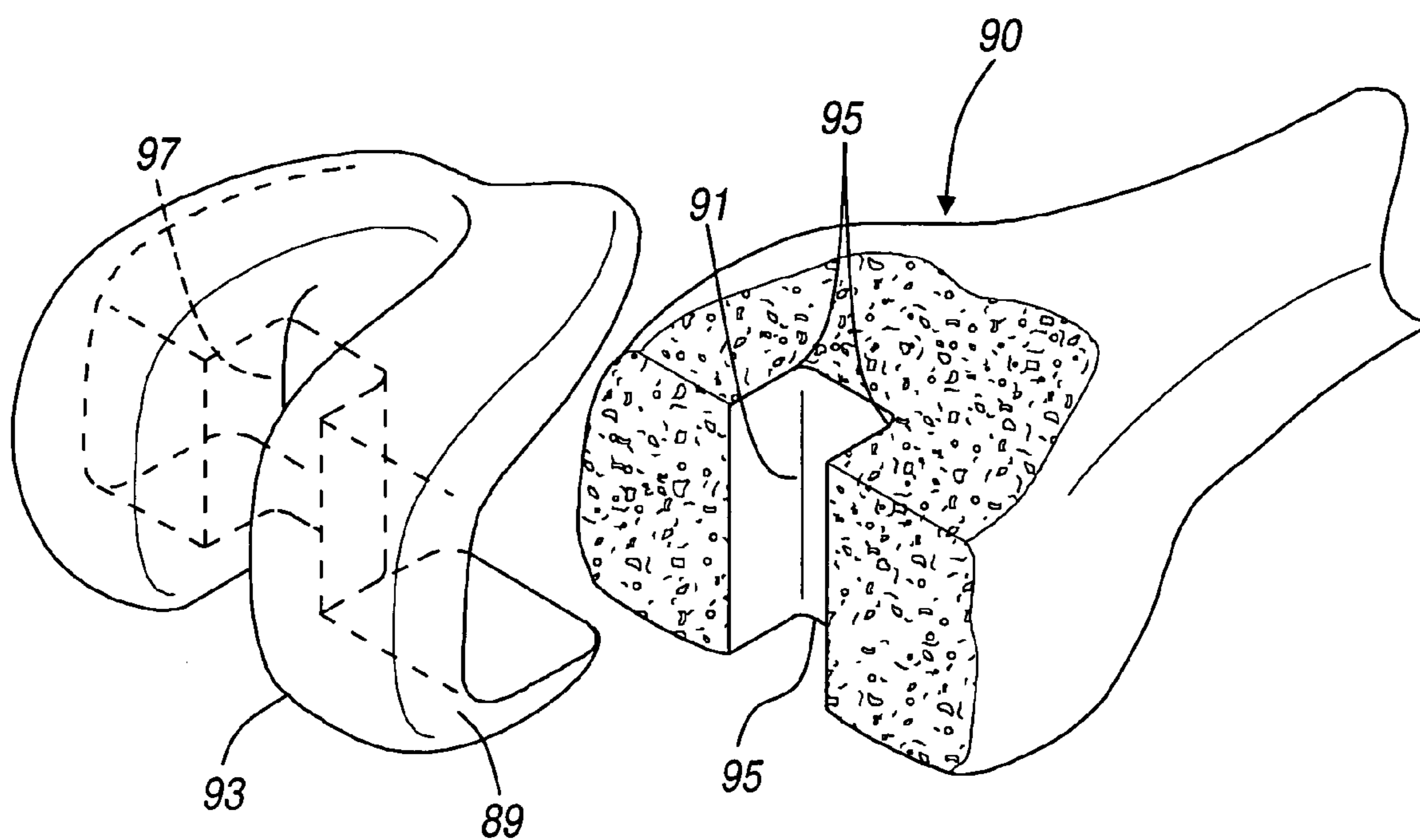


FIG. 6

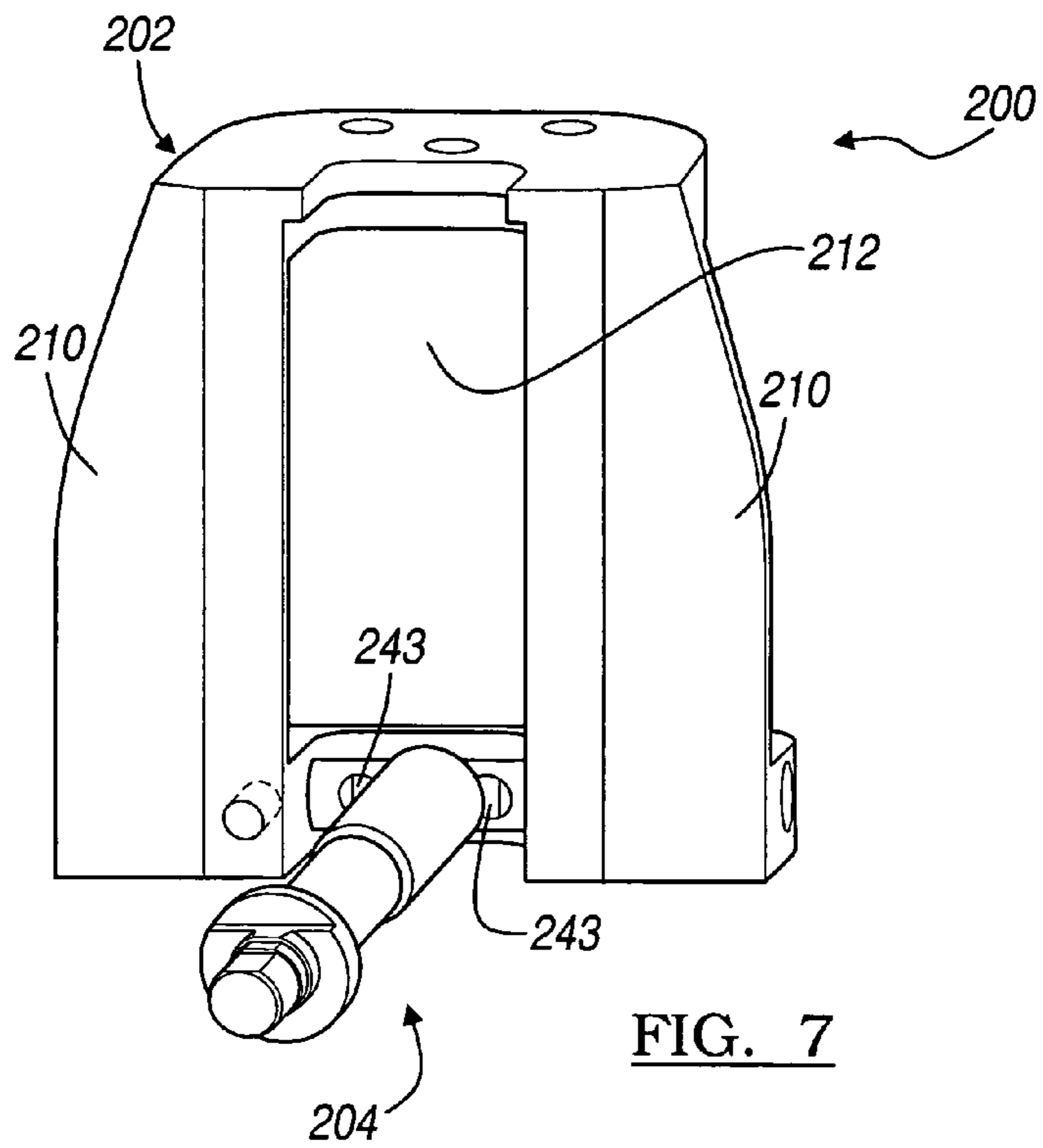
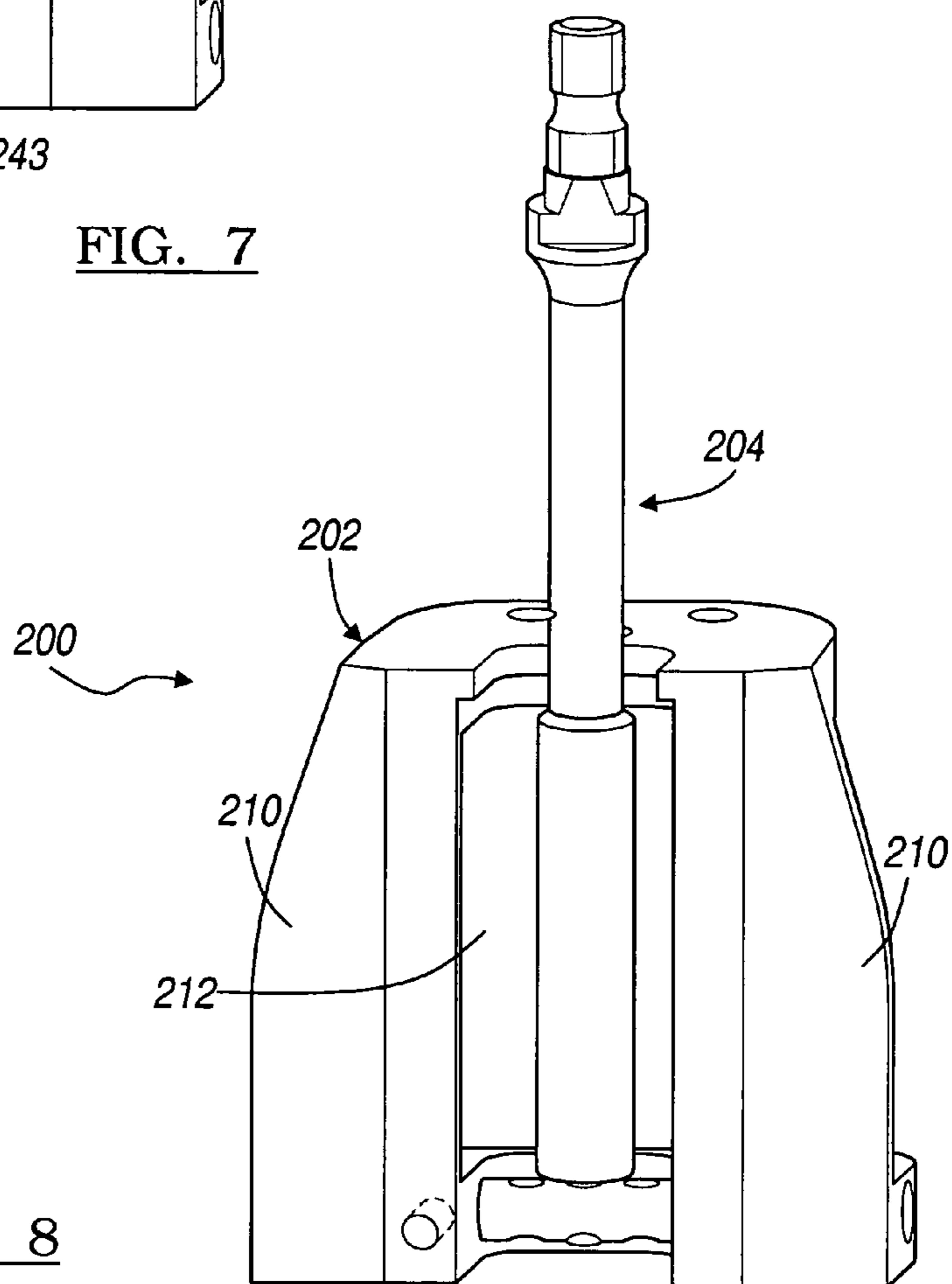


FIG. 8



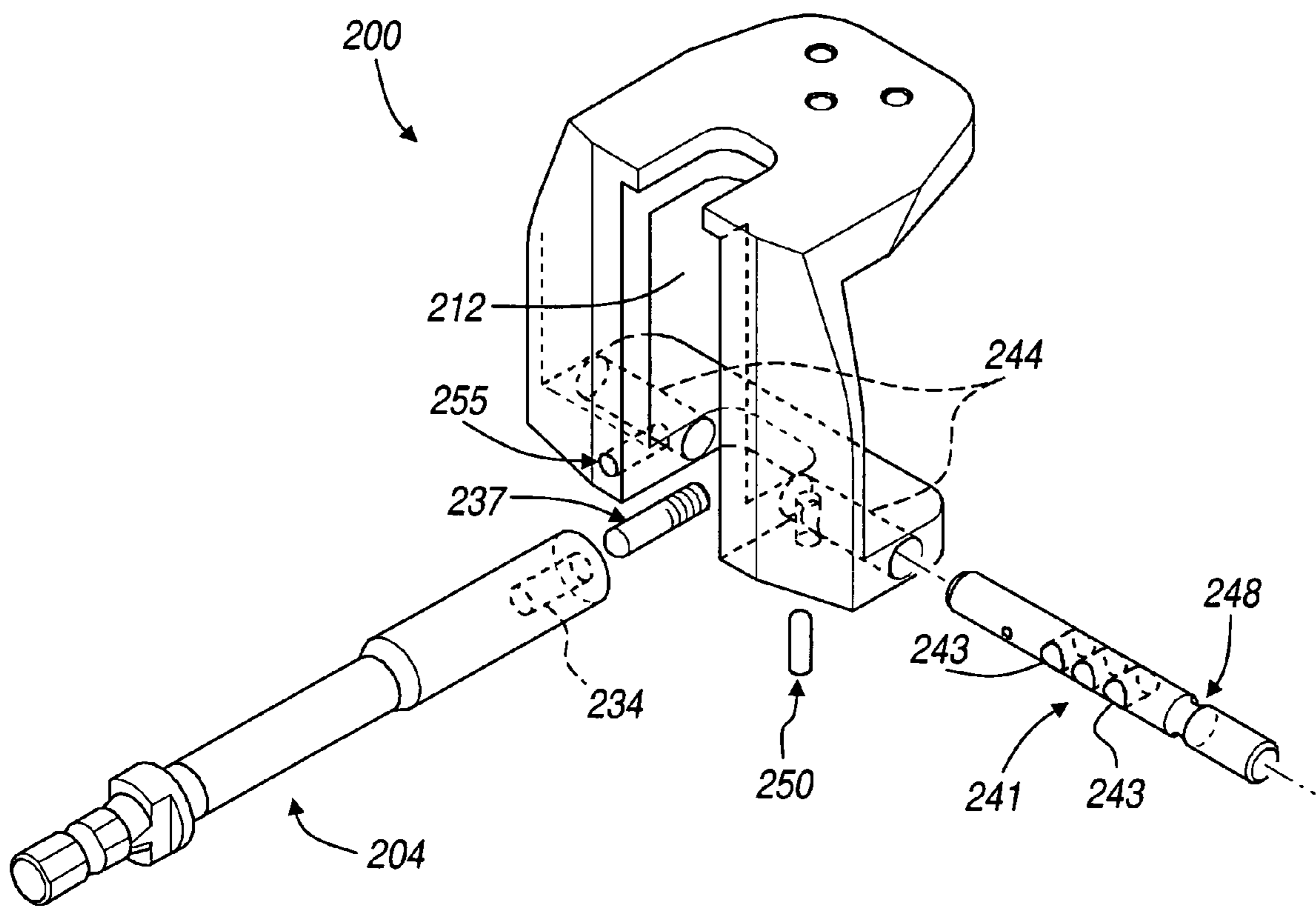
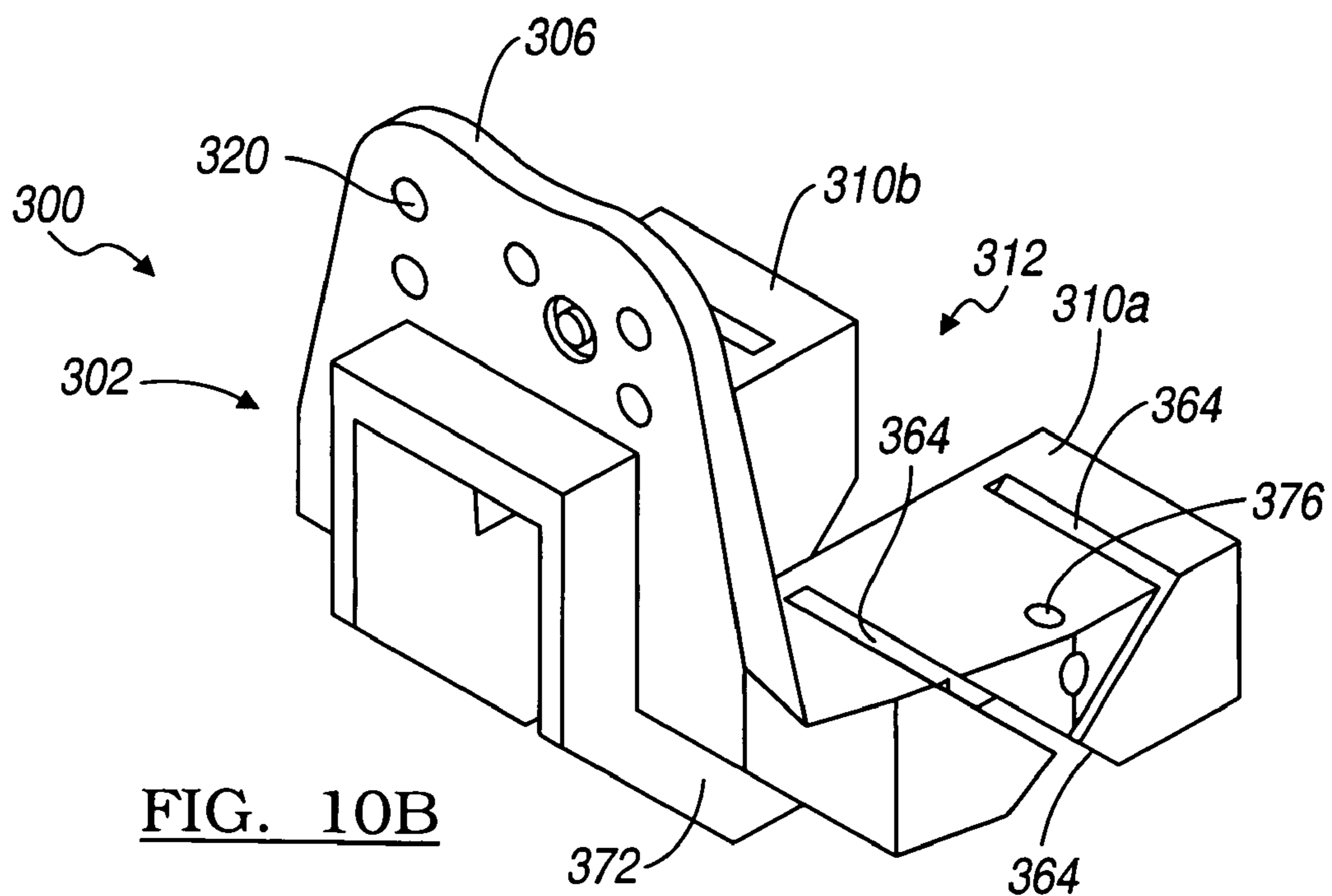
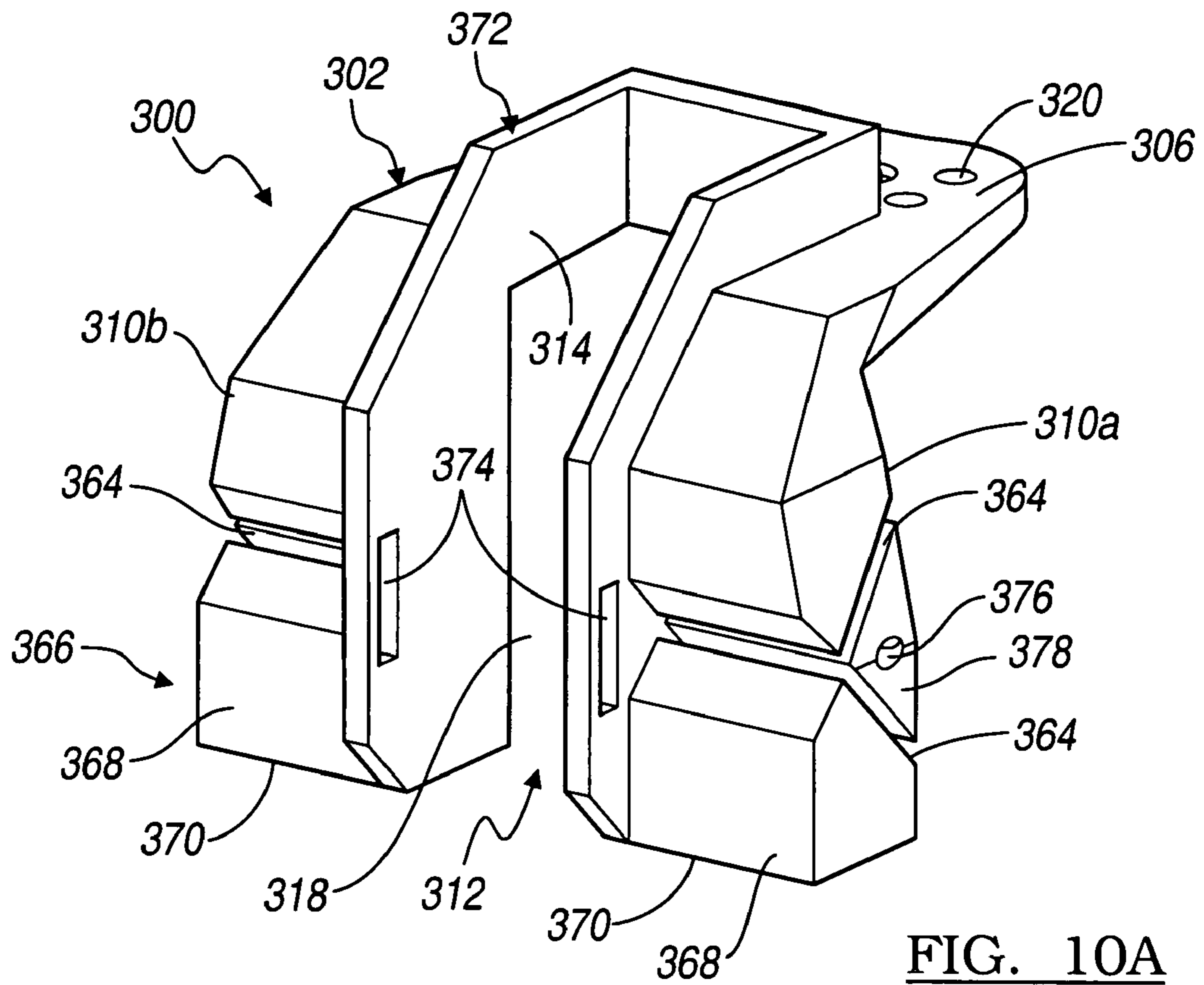


FIG. 9



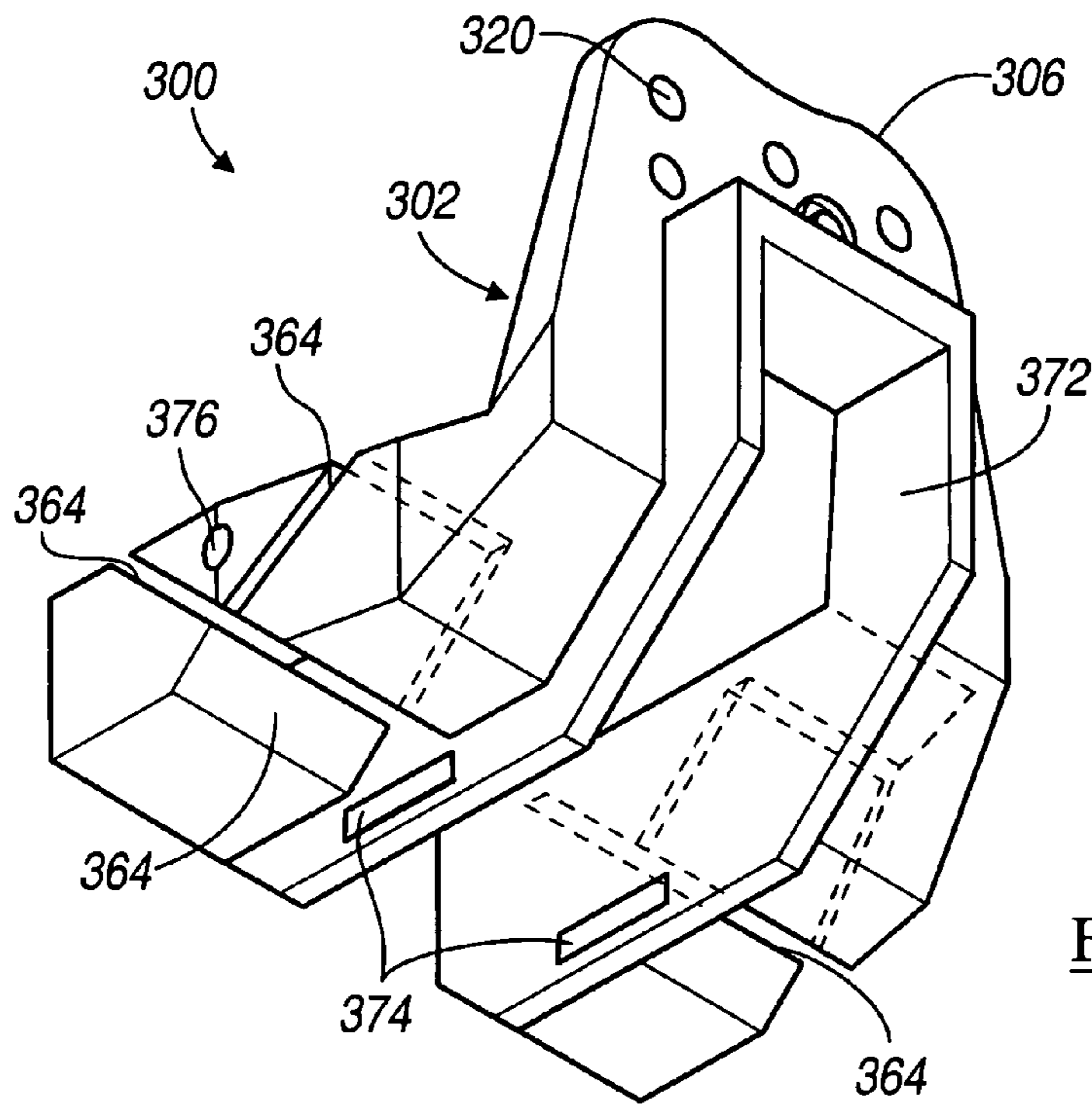


FIG. 10C

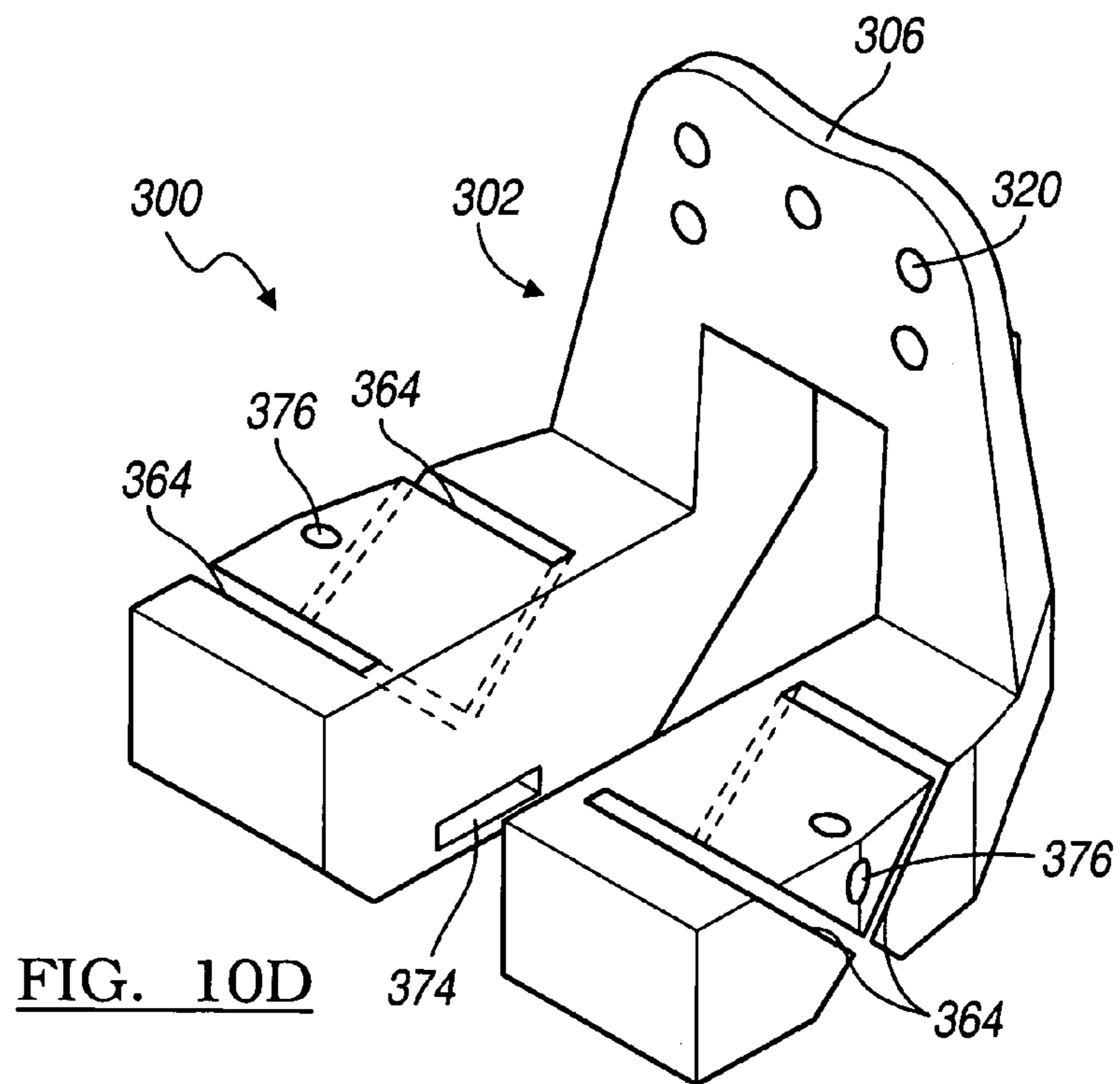
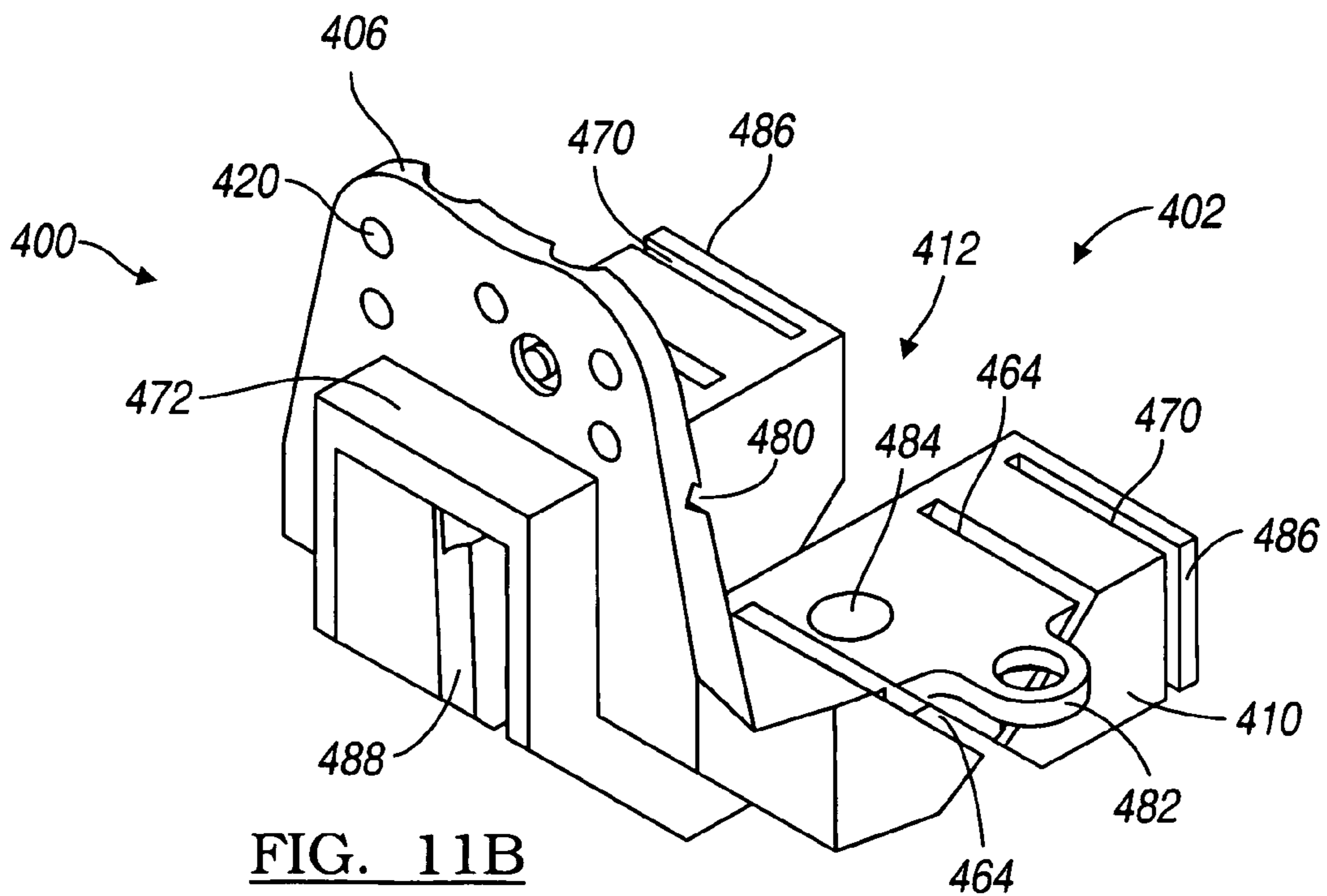
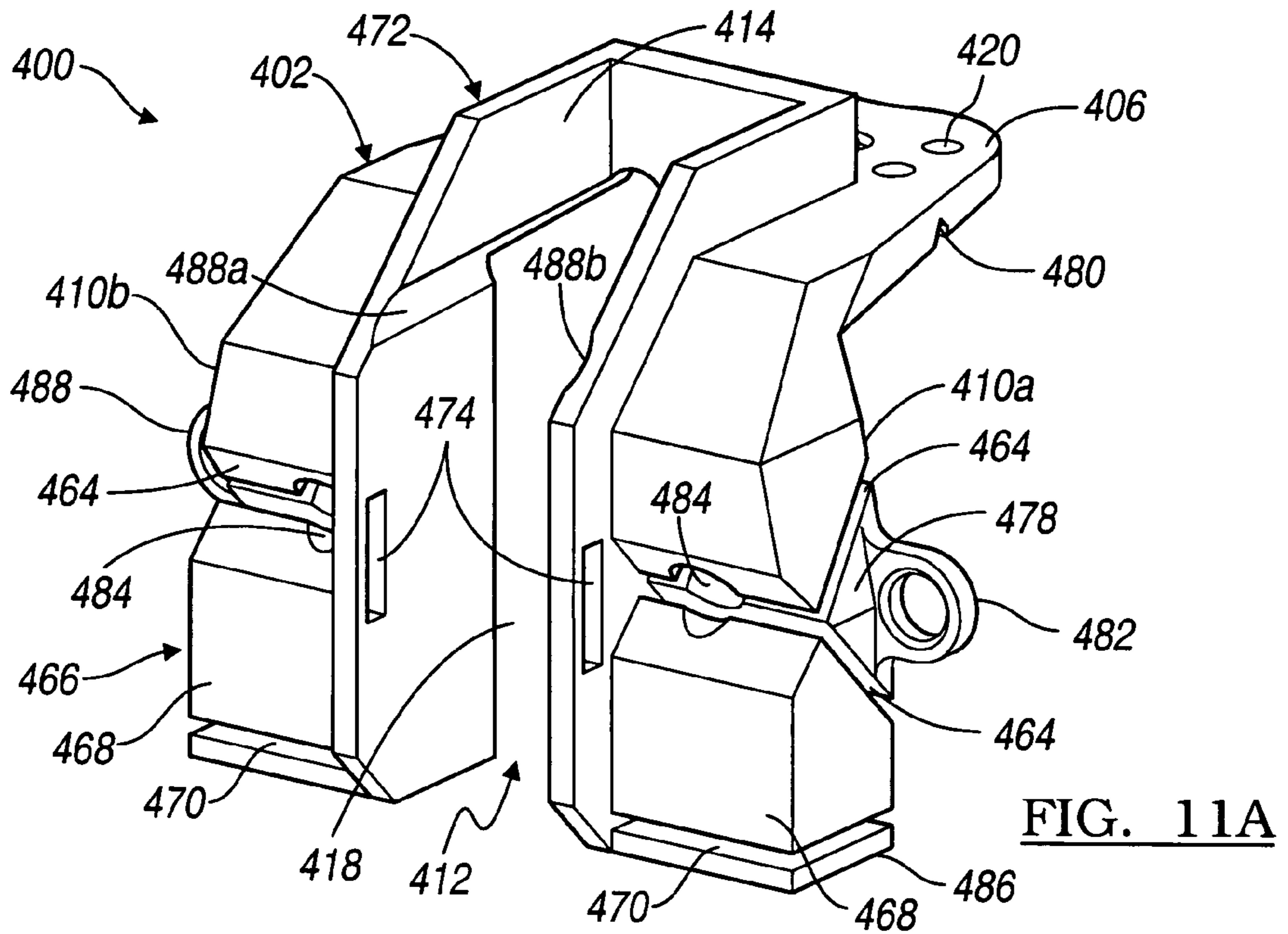


FIG. 10D



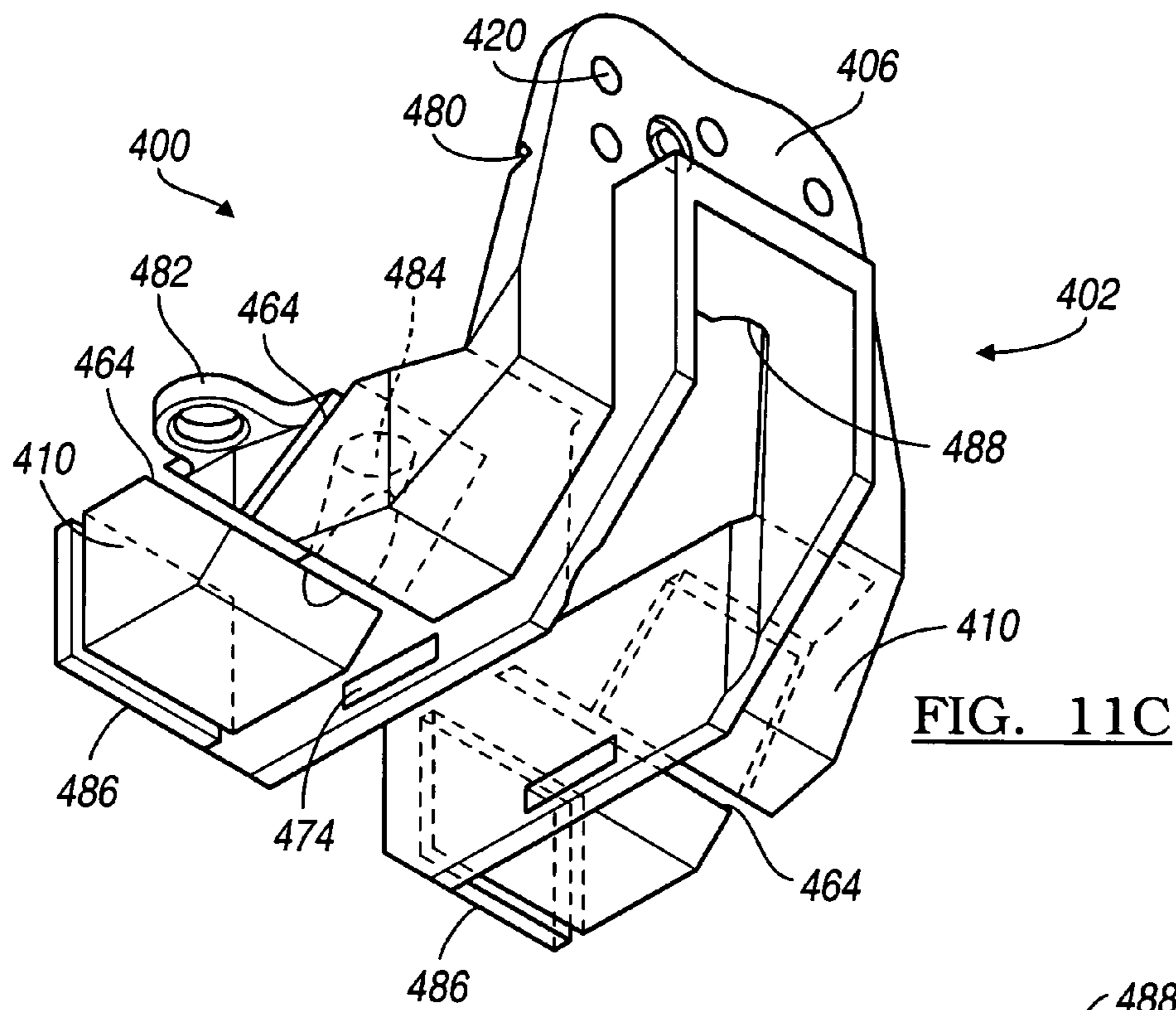


FIG. 11C

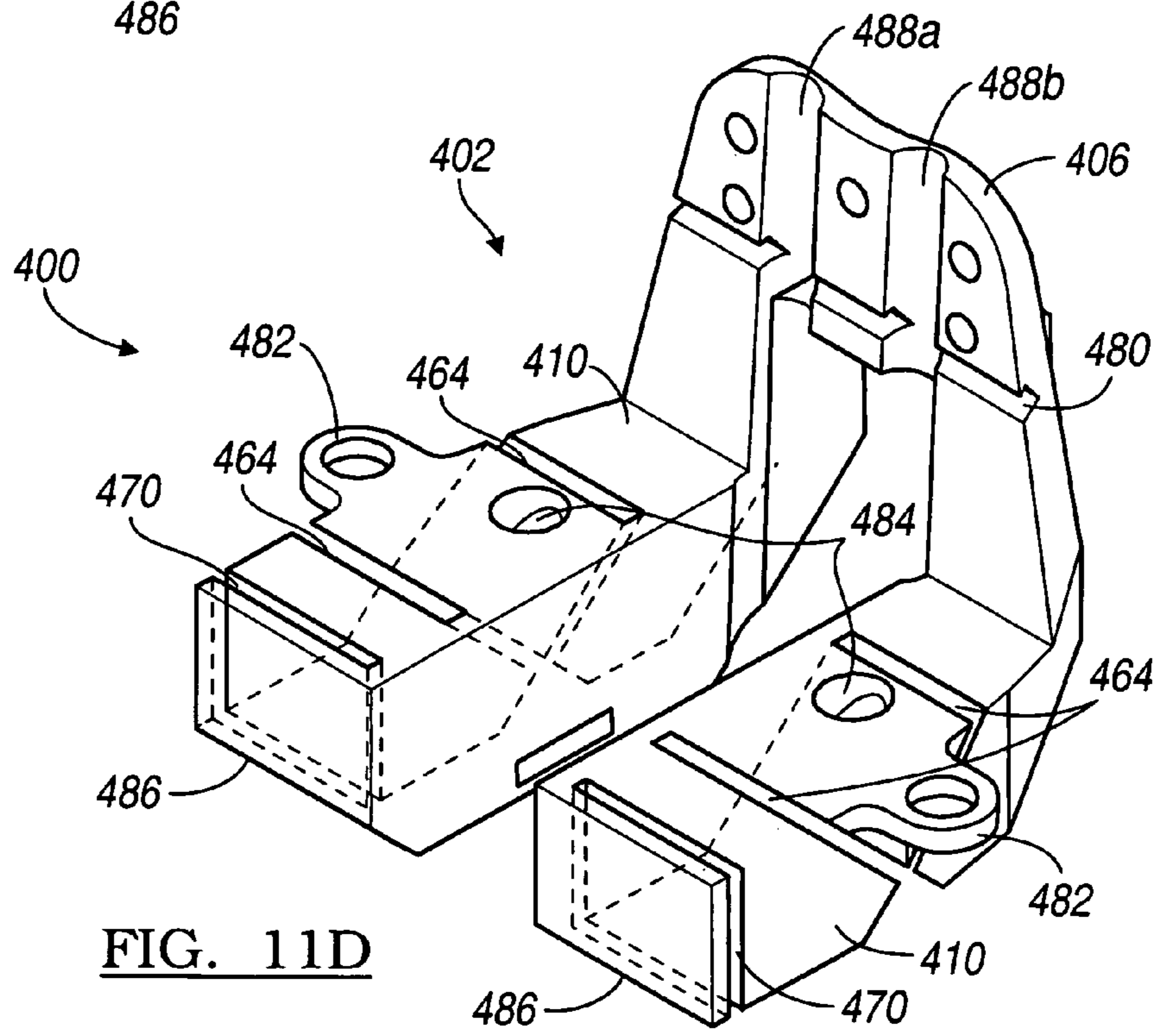
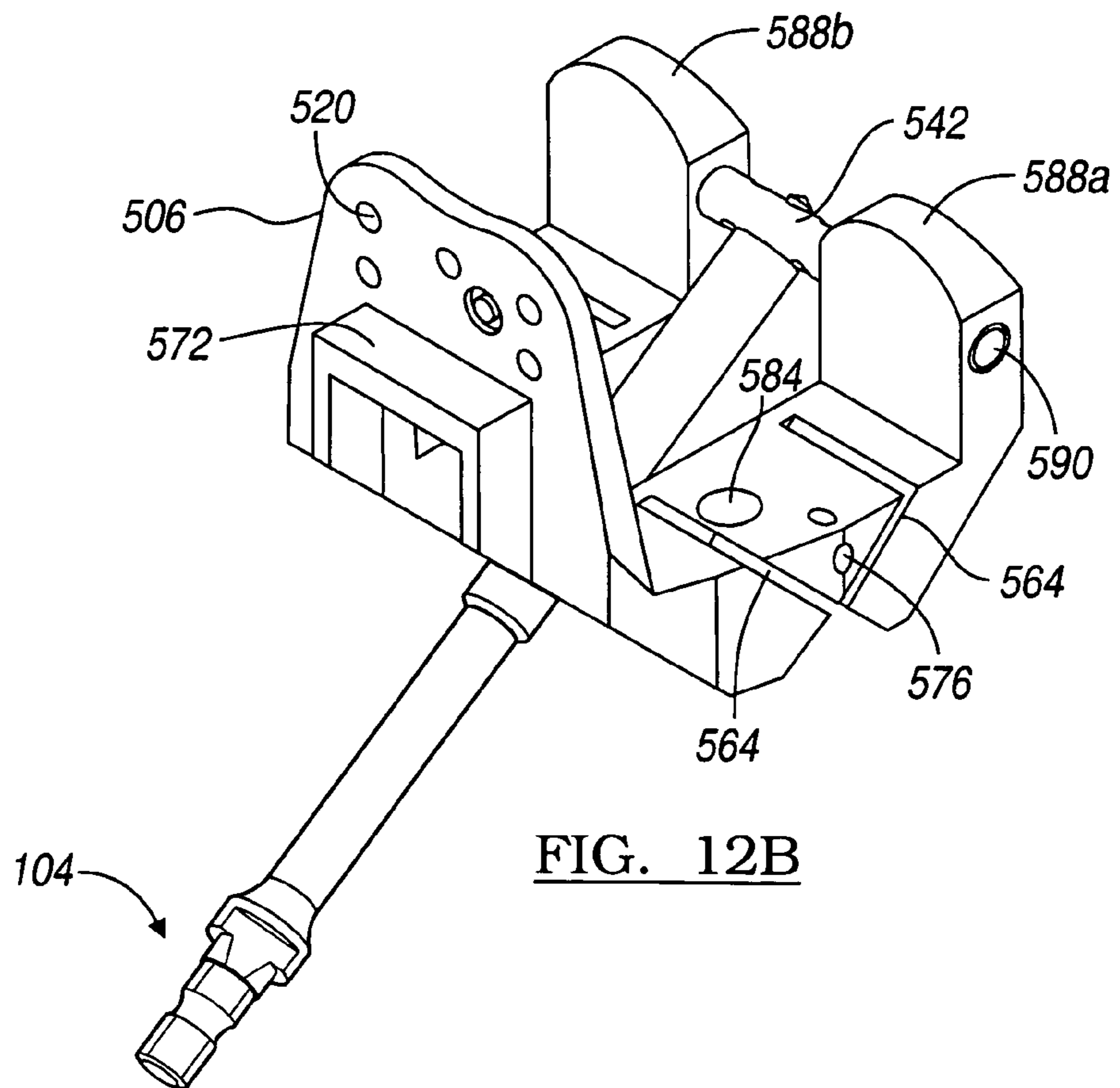
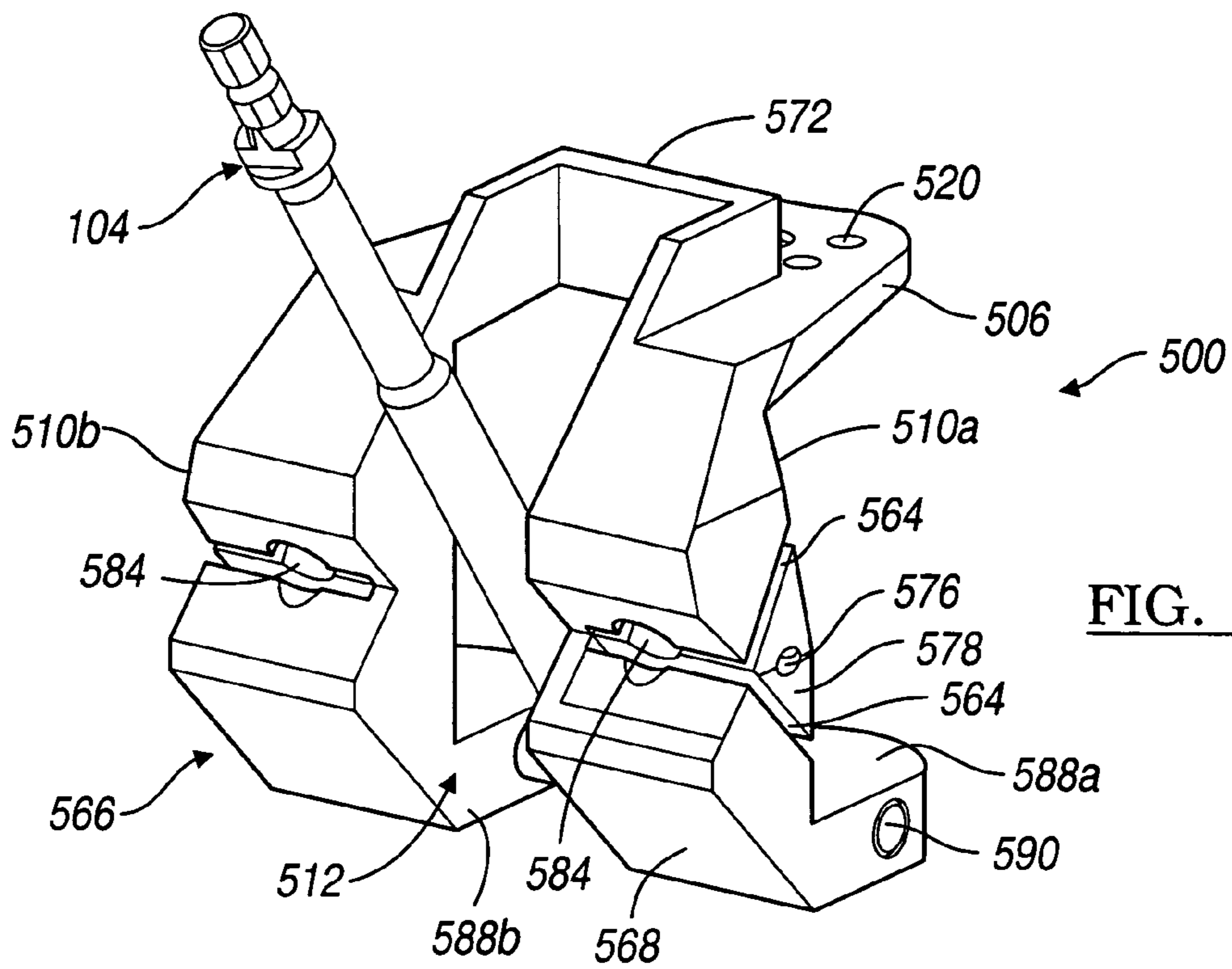


FIG. 11D



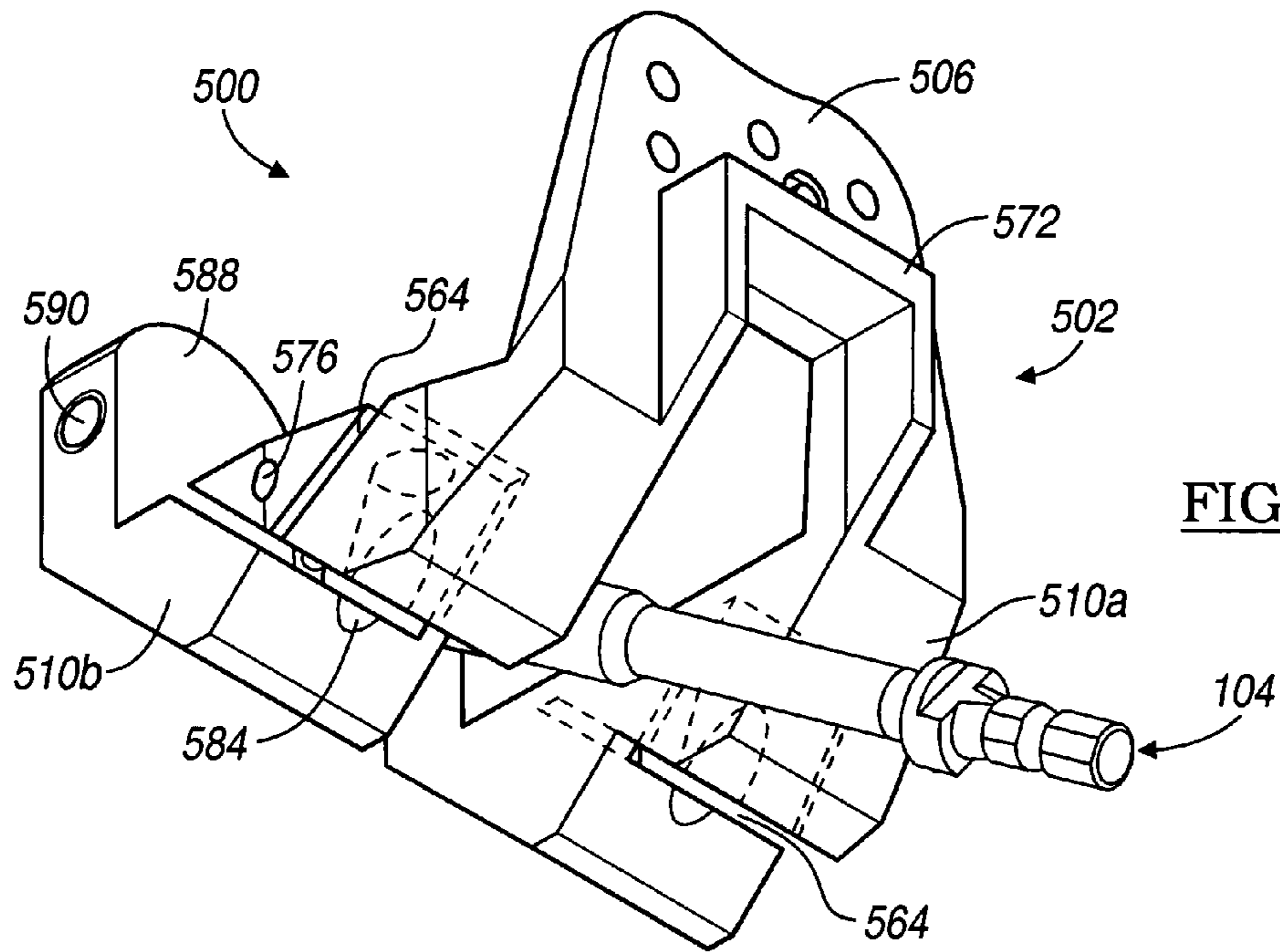


FIG. 12C

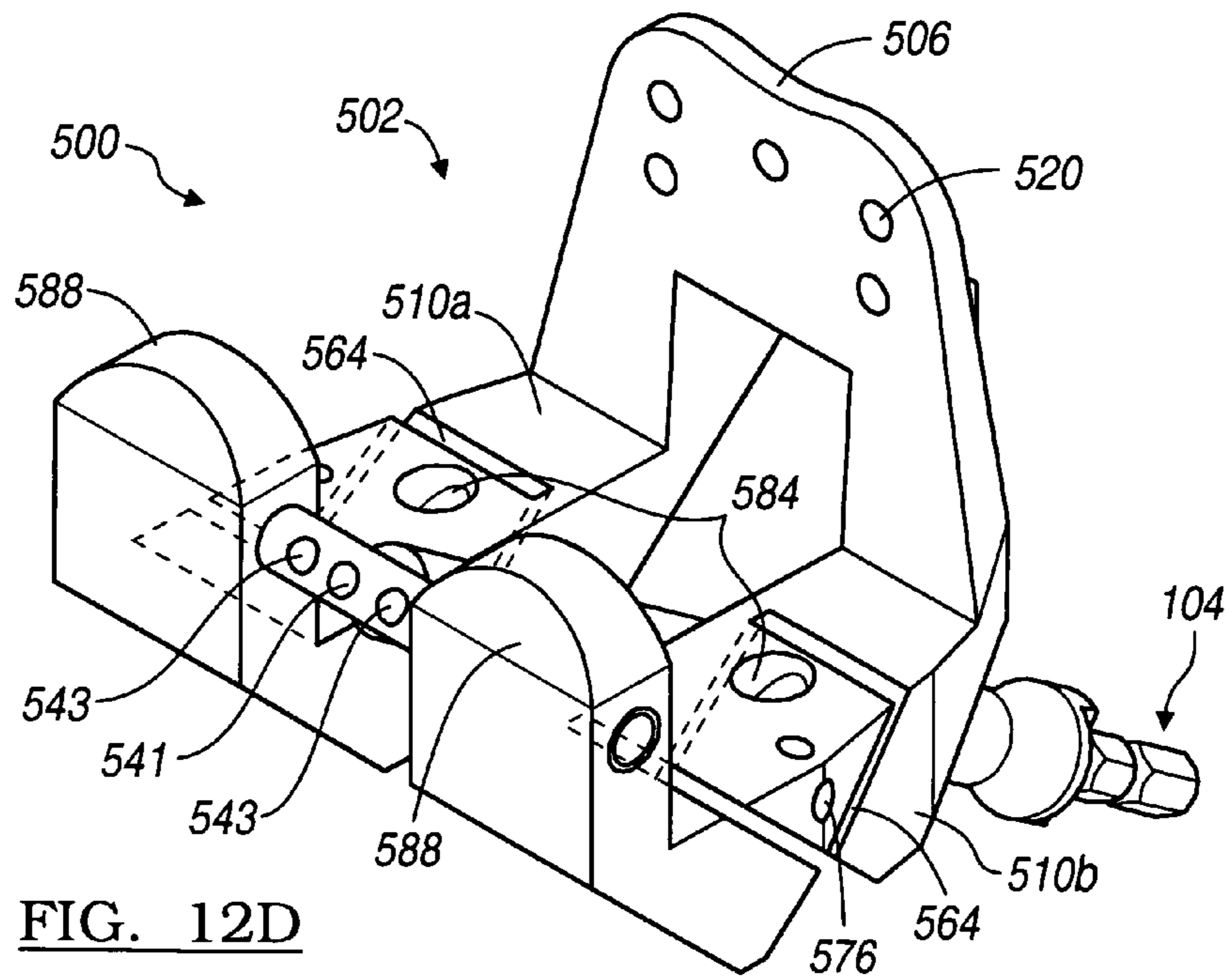


FIG. 12D

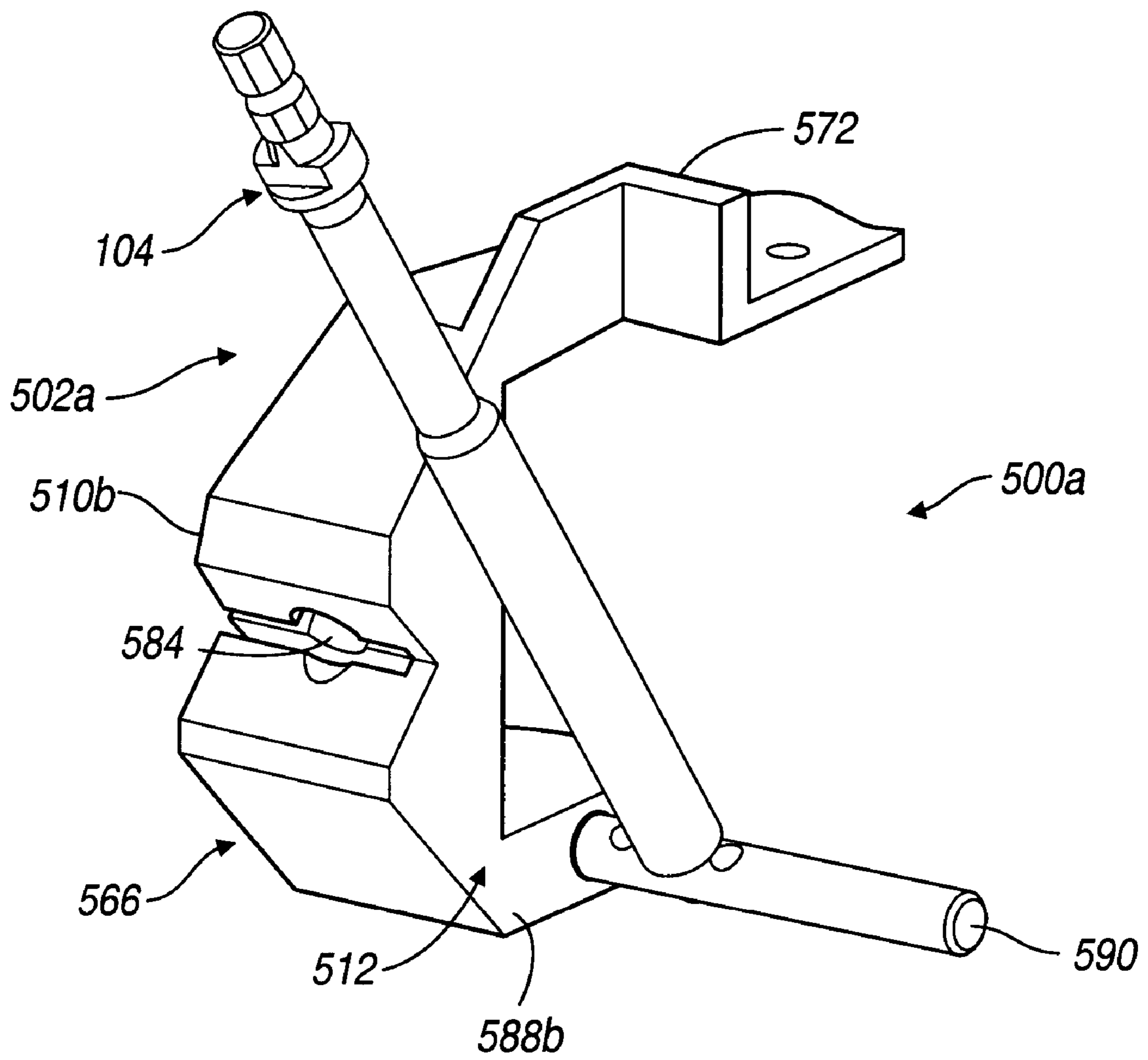


FIG. 13

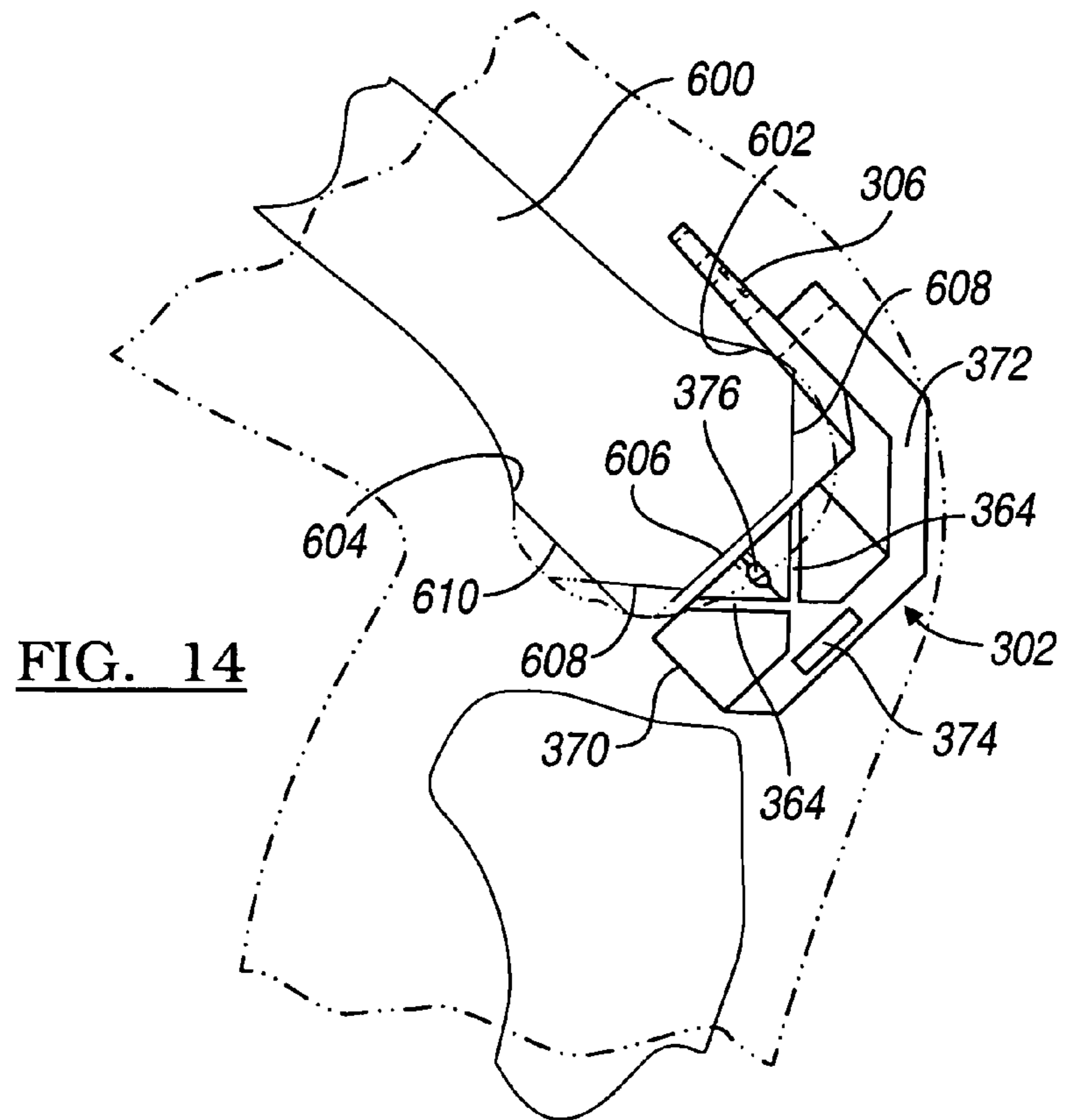


FIG. 14

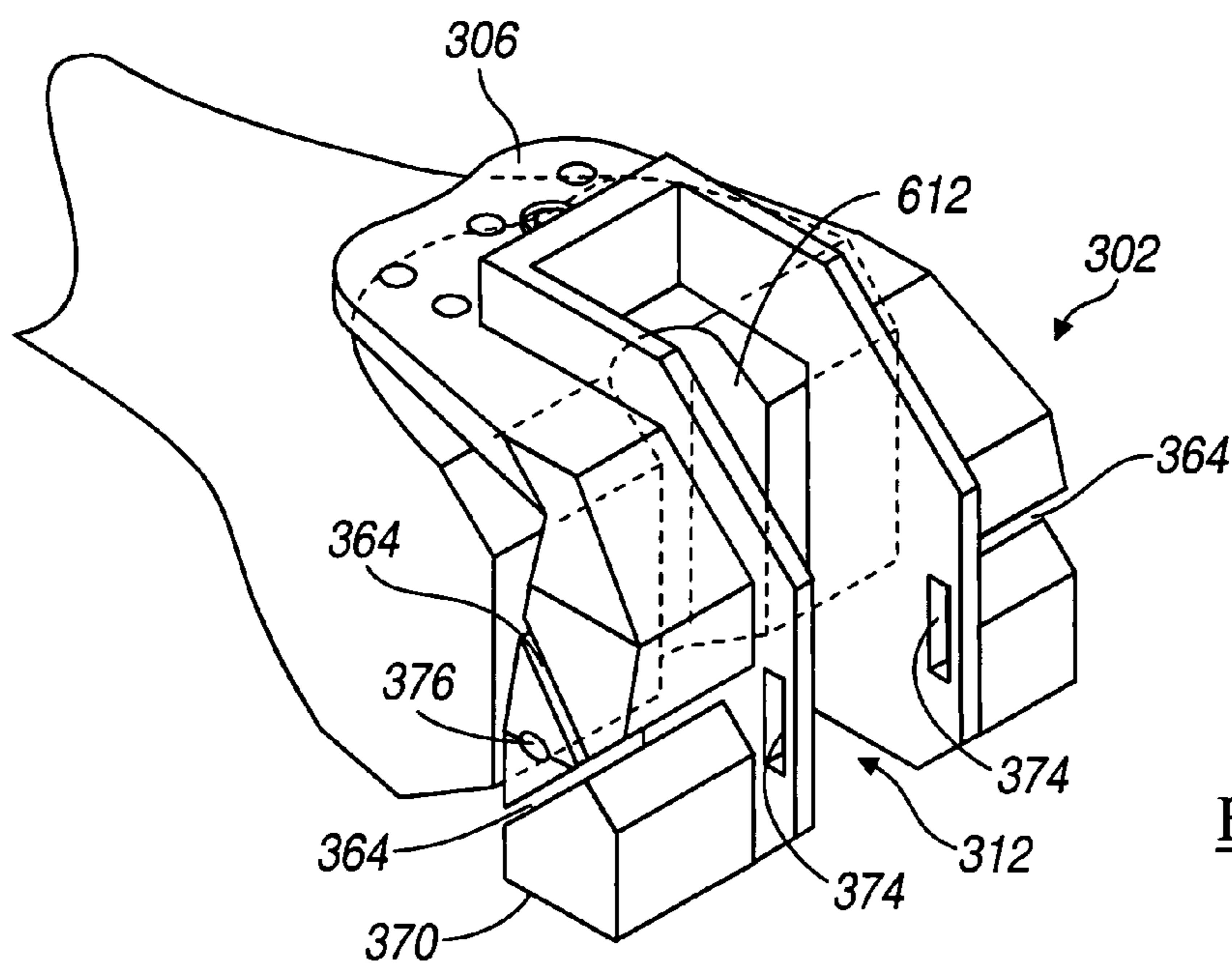


FIG. 15

1

BONE CUTTING APPARATUS

This application is a continuation-in-part of U.S. patent application Ser. No. 10/680,902 filed on Oct. 8, 2003, now U.S. Pat. No. 7,364,580 issued on Apr. 29, 2008. The disclosure of the above application is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to a bone-cutting apparatus and associated method.

BACKGROUND OF THE INVENTION

Healthy knee joints include two cruciate ligaments, the anterior cruciate ligament (ACL) and the posterior cruciate ligament (PCL). The ACL is often damaged in diseased or injured knee joints, and may be removed during total knee replacement. It is considered desirable, however, to retain the PCL because of its importance for the stability of the knee during bending. When the PCL is damaged beyond repair or otherwise must be removed, a posterior stabilized knee prosthesis is implanted. This prosthesis includes a femoral component with an intercondylar box-shaped part. Therefore, a similarly box-shaped intercondylar bone portion must be resected from the femur to accommodate the femoral component.

Knee joints that require posterior stabilized knee prosthesis are typically severely damaged and intercondylar box resection is a challenging and painstaking procedure. Several cutting guides and milling devices have been developed to assist the surgeon in this procedure. Typically, two or more such guides, each designed to perform different resections, are needed to perform this procedure. The use of multiple guides increases the duration, complexity and cost of the procedure and is less than desirable. Therefore, there is a need for a single guide that can be used to perform multiple different resections.

SUMMARY OF THE INVENTION

In one form the invention provides for a guide for cutting a bone comprising an anterior portion and a distal portion orientated at about a right angle to the anterior portion. The distal portion includes a guiding side, a distal surface at the guiding side, a box-cut shaped opening defined by the guiding side, a plurality of first cutting surfaces disposed at the guiding side at an acute angle relative to the distal surface of the guiding side operable to guide a cutting device to the bone to form chamfer cuts in the bone, and a second cutting surface disposed at the guiding side at at least about a right angle to the distal surface operable to guide a cutting device to the bone to form a posterior cut in the bone.

In another form the invention includes a guide for cutting bone comprising an anterior portion, a posterior portion, a distal portion, a box-cut shaped opening, and a rotatable rod. The posterior portion is orientated at least approximately parallel to the anterior portion. The posterior portion includes a first posterior flange and a second posterior flange. A distal portion is orientated at least an approximate right angle to each of the anterior portion and the posterior portion. The distal portion includes a distal surface, a first guiding side, a second guiding side spaced apart from the first guiding side, and a plurality of cutting surfaces disposed at each of the first guiding side and the second guiding side at an acute angle relative to the distal surface of the first and second guiding

2

sides operable to guide a cutting device to the bone to form chamfer cuts in the bone. The box-cut shaped opening is defined by the anterior portion, the first guiding side, the second guiding side, the first posterior flange, and the second posterior flange. The rotatable rod extends between the first posterior flange and the second posterior flange, the rotatable rod including a hole operable to receive and guide a cutting device for forming a box cut in the bone.

In yet another form, the present invention provides for a method for guiding a cutting device to a bone to form chamfer cuts, posterior cuts, and a box cut in the bone, the method includes: positioning a cutting guide on the bone such that an anterior portion of the cutting guide abuts an anterior bone surface and a distal portion of the cutting guide abuts a distal bone surface, the distal portion includes a first guiding side and a second guiding side defining a box-cut shaped opening; cutting chamfer cuts in the bone by directing the bone cutting device along each of a plurality of first cutting surfaces disposed at each of the first guiding side and the second guiding side, the first cutting surfaces disposed at an acute angle relative to a distal surface of the guide; and cutting posterior cuts in the bone by directing the bone cutting device along second cutting surfaces disposed at each of the first guiding side and the second guiding side, the second cutting surfaces disposed at about a right angle to the distal surface of the guide.

Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

FIG. 1 is a perspective view of an embodiment of the bone cutting apparatus of the present invention, shown in a first position;

FIG. 2 is a perspective view of an embodiment of the bone cutting apparatus of the present invention, shown in a second position and a first lateral location;

FIG. 3 is an exploded perspective view of an embodiment of the bone cutting apparatus of the present invention, shown in the first position;

FIG. 4 is an environmental view of the embodiment of FIG. 1;

FIG. 5 is the embodiment of FIG. 2, shown in a second position and a second lateral location;

FIG. 6 is an exploded view of a portion of a distal femur prepared to receive a femoral component according to an embodiment of the present invention;

FIG. 7 is a perspective view of an embodiment of the bone cutting apparatus of the present invention, shown in a first position;

FIG. 8 is a perspective view of the bone cutting apparatus of FIG. 7, shown in a second position;

FIG. 9 is an exploded view of the bone cutting apparatus of FIG. 7;

FIG. 10A is a first perspective view of another embodiment of the bone cutting device of the present invention;

FIG. 10B is a second perspective view of the bone cutting device of FIG. 10A;

FIG. 10C is a third perspective view of the bone cutting device of FIG. 10A;

FIG. 10D is a fourth perspective view of the bone cutting device of FIG. 10A;

FIG. 11A is a first perspective view of a bone cutting device according to an additional embodiment of the present invention;

FIG. 11B is a second perspective view of the bone cutting device of FIG. 11A;

FIG. 11C is a third perspective view of the bone cutting device of FIG. 11A;

FIG. 11D is a fourth perspective view of a bone cutting device of FIG. 11A;

FIG. 12A is a first perspective view of a bone cutting device according to a further embodiment of the present invention;

FIG. 12B is a second perspective view of a bone cutting device of FIG. 12A;

FIG. 12C is a third perspective view of a bone cutting device of FIG. 12A;

FIG. 12D is a fourth perspective view of a bone cutting device of FIG. 12A;

FIG. 13 is a perspective view of a bone cutting device according to a further embodiment of the present invention;

FIG. 14 is a side view of the bone cutting device of FIG. 10 mounted to a patient's femur; and

FIG. 15 is a perspective view of the bone cutting device of FIG. 10 mounted to a patient's femur.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS

The following description of various embodiments is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

Referring to FIG. 1, an embodiment of a bone-cutting apparatus 100 according the present invention is shown. The apparatus includes a guide 102 and a mill or reamer or similar cutting tool 104 that can rotate about its own longitudinal axis "D." The guide 102 may be a generally U-shaped member that includes a flange or anterior portion 106 and a base or posterior portion 108. The flange 106 and the base 108 are joined by a pair of guiding sides 110 at a distal portion 166, which are substantially orthogonal to the flange 106 and the base 108.

The guide 102 includes a generally "box-cut" shaped opening 112, which is defined by a U-shaped flange cutout 114, a U-shaped base cutout 116 and a rectangular spacing 118 between the guiding sides 110. The box-cut opening 112 is substantially sized and shaped to conform to the amount of bone that must be removed from a bone before inserting a portion of a prosthesis component. For example, in a posterior stabilized knee prosthesis, the opening 112 is sized for the removal of intercondylar bone which is necessary for the insertion of an intercondylar box 97 of the prosthesis (FIG. 6). In the following description, the bone-cutting apparatus 100, is described in reference to posterior stabilized knee prosthesis for the sake of clarity, but it is should be appreciated that the apparatus 100, as well as the other bone cutting apparatuses described herein, is not restricted to such use.

The flange 106 may include a plurality of holes 120 for securing the apparatus 100 to a bone using suitable removable fasteners 122, such as bone nails, drill bits, pins, etc. In a posterior stabilized knee prosthesis, for example, the apparatus 100 is used on the resected distal femur 90, as shown in FIG. 4. The flange 106 is placed on the resected anterior surface 92 and secured thereon with the fasteners 122. The base 108 is placed under the resected posterior surface 94, such that the guiding sides 110 are in front of the resected medial and lateral condyles 96, 98, shown for a right knee in

FIG. 4. In this position, the opening 112 of the guide 102 may be aligned to remove an intercondylar bone portion 99.

The mill 104 is pivotably connected to the guide 102, such that it can rotate in the direction of an arrow "A" toward the flange 106 from a first position, shown in FIG. 1 to a last position shown in FIG. 2, and any position intermediate the first and the last positions. The term "second position" as used herein includes the last position and all the positions that span the interval between the first position and the last position in the direction of the arrow A.

In the first position, the mill 104 is substantially coplanar or parallel to the base 108 and it can move laterally along a lateral axis "B." In the last position, the mill 104 is prevented from rotating further in the direction of the arrow A by a stopping wall 126 of the flange cutout 114.

For a posterior stabilized knee prosthesis, the mill 104 is adjacent to the posterior surface 94 in the first position, and adjacent to the anterior surface 92 in the last position. The angle between the first and last positions is substantially 90° for a posterior stabilized knee prosthesis, but other angles less or greater than 90° may be provided by changing the depth of the flange cutout 114 or the angle of the guiding sides 110 with the flange 106 for other applications that do not require resection of rectangular bone portions.

Referring to FIG. 5, the mill 104 includes a driven end 128, which may be connected to a spindle for power driven rotation or to a crank handle for manual rotation, and a shaft 130 with a cutting portion 132. The cutting portion 132 includes a bore 134 which rotatably receives a pivot pin 136. The pivot pin 136 has a threaded end 138 that engages a center receptacle that can take the form of a slot 140 in a cutting device receiver, which can take the form of a rod 142. The rod 142 is sized to be received in two halves 144a, 144b of a split bore 144 in the base 108, and is oriented coaxially with the lateral axis B. The rod 142 may be moved along the lateral axis B to allow lateral repositioning of the mill 104 relative to the box-cut opening 112.

In one embodiment, the rod 142 slides within the bore 144, such that the mill 104 is easily repositioned by manually shifting the shaft 130 laterally, i.e. in a direction parallel to the lateral axis B, thereby causing the rod 142 to slide within the bore 144. It will be appreciated that in some other applications, it may be desirable to control the lateral movement of the mill 104 by controlling the movement of the rod 142, such as, for example, by providing for threaded engagement between a portion of the rod 142 and a portion of the bore 144 and advancing the rod 142 using a tool such as a screwdriver or socket at one end of the rod 142, or other means within the purview of an artisan of ordinary skill.

In one embodiment, to better stabilize the mill 104 during cutting, lateral movement and repositioning of mill 104 is only permitted when the mill 104 is in the first position, in which no cutting occurs. When the mill 104 is pivoted toward the flange 106, lateral movement of the mill 104 may be prevented by preventing lateral movement of the rod 142. Thus, during pivoting, the mill 104 may be constrained to remain on a single cutting plane "C", i.e. on a plane that is perpendicular to the lateral axis B. Such lateral constraint may not be necessary for certain applications.

In one embodiment, the rod 142 may include one or more grooves 148 located at predetermined intervals along a first portion 143 of the rod 142. The grooves 148 are positioned such that one of them can selectively capture a pin 150 when the mill 104 is pivoted in the direction of the arrow A. The pin 150 is attached substantially perpendicularly to the base 108 and traverses the first half 144a of the bore 144. When the pin 150 is captured by one of the grooves 148, it prevents any

lateral movement of the rod **142**, thus stabilizing the lateral position of the mill **104** during cutting. The grooves **148** are truncated, i.e. they do not extend over the entire circumference of the rod **142**, terminating at a chamfered portion **146** of the rod **142**, which is oriented relative to the center slot **140** such that the pin **150** is not captured by any of the grooves **148**, when the mill **104** is in the first position. When the mill **104** is pivoted about the lateral axis B, the rod **142** rotates about the same axis such that one of the grooves **148** captures the pin **150**.

The rod **142** may include a set of detents **152** located on a second portion **145** of the rod **142**. The first and second portions **143**, **145** of the rod **142** are on opposite sides of the center slot **140** and are received within the respective halves **144a**, **144b** of the split bore **144**. The detents **152** may extend over the entire circumference of the rod **142**. A commercially available spring-loaded ball plunger **154** may be inserted in a hole **155** of the base **108** to selectively engage one of the detents **152**. The detents **152** are placed at locations symmetric to the locations of the grooves **148** about the center slot **140**, such that a desired lateral location for the mill **104** may be easily selected by moving the mill **104** laterally, while in the first position, until the ball **160** of the ball plunger **154** snaps into the appropriate detent **152**. The ball plunger **154** and the detents **152**, in cooperation with the grooves **148** and the pin **150**, define an indexing mechanism **162** for quick lateral positioning and repositioning of the mill **104**.

In one embodiment, there are three grooves **148** corresponding to three lateral locations of the mill **104** in relation to the opening **112**, such that operation of the mill **104** in each lateral location removes one third ($\frac{1}{3}$) of the intercondylar bone **99**. Two of these lateral locations are illustrated in FIGS. **2** and **5**, in which the mill **104** has been pivoted to the last position. Depending on the quality/strength characteristics of the bone and the size of the bone **90** in the lateral dimension, i.e. the dimension along the lateral axis B and the size of the cutting portion **132** of the mill **104**, a smaller or greater number of grooves **148** may be used. For fragile or damaged bone, for example, it may be desirable to use a greater number of smaller width cuts, in which case the rod **142** is provided with greater number of grooves **148** delineating a corresponding number of lateral locations.

Similarly, it will be appreciated that the number of lateral shifts of the mill **104** that are required for the removal of the bone portion **99** depends on the width of the bone portion **99** relative to the diameter of the cutting portion **132** of the mill **104**. Therefore, it is also possible to remove the entire bone portion **99** with single pass of the mill **104**, that is without need for any lateral shifting, if the diameter of the mill **104** substantially conforms to the size of the bone portion **99**.

After the bone portion **99** is removed, a box-like cavity **91** with rounded corners **95** is defined in the bone **90** for receiving a femoral component **93**, as shown in FIG. **6**. When a small-diameter mill **104** is used, the corners **95** of the cavity **91** will have a smaller radius as compared to when a bigger diameter mill **104** is used. If right-angle corners are desired in a particular application, the surgeon could chisel the corners **95** of the cavity **91** to form right-angle corners **95**. The guide **102** has two lateral surfaces **111**, which are shaped similarly to corresponding lateral sides **89** of the femoral component **93** to aid in positioning the guide **102**.

In operation, the bone-cutting apparatus **100** is attached to the resected bone **90** by inserting the bone **90** between the flange **106** and the base **108**, such that the volume of the bone portion **99** to be removed is framed by the box-cut opening **112** of the apparatus **100**. The apparatus **100** is then secured by attaching the flange **106** to the bone **90** with fasteners **122**.

Starting from the first position, the mill **104** is moved along the lateral axis B to a first lateral location while at the first position. The mill **104** is then rotated (spun) manually or by power, and is also pivoted from the first position to a second position, while remaining locked in the first lateral location and cutting through a segment of bone portion **99**. Next, the mill **104** is returned to the first position and is shifted to a second lateral location along the lateral axis B, while in the first position. The shifting, pivoting and cutting process is repeated as necessary until the entire bone portion **99** is removed. During this procedure, selecting each of the lateral locations, i.e. moving the mill **104** from one to another cutting plane C, may be facilitated by the indexing mechanism **162**.

Another embodiment of the bone cutting apparatus **200** is illustrated in FIGS. **7-9**. Elements common to embodiments **100** and **200** are referenced with numerals having the same second and third digits and prefaced by the digit **1** or **2** respectively, such as for example, the mill **104**, **204**. The description of elements common to both embodiments will not be repeated. In this embodiment, the rod **242** includes one groove **248** that captures the pin **250** to prevent lateral movement of the rod **242**. The rod **242** includes a center hole **241** and two side holes **243**, corresponding to the medial and lateral positions. To make a cut in the lateral or medial position, the mill **204** is removed from the center hole **241** of the rod **242** and is inserted in one of the side holes **243**. To facilitate the engagement and disengagement of the mill **204** to and from the rod **142**, the mill **204** includes a press-fit guide pin **237** which snaps inside one of the three holes **241**, **243** and rotates with the mill **204**.

A bone cutting apparatus according to an additional embodiment is illustrated in FIG. **10** at reference numeral **300**. Elements common to embodiments **100** and **200** are referenced with numerals having the same second and third digits and prefaced by the digit **3**. The above description of the like elements also applies to the apparatus **300**.

The guide **302** further includes a plurality of first cutting surfaces **364**. The cutting surfaces **364** extend through each of the first guiding side **310a** and the second guiding side **310b**, which generally form a distal portion **366** of the guide **302**. As illustrated, each of the guiding sides **310** include two cutting surfaces **364**. However, each guiding side **310** can include any suitable number of the first cutting surfaces **364** depending on the particular application.

The first cutting surfaces **364** are typically orientated at an acute angle relative to a distal surface **368** of the guiding sides **310**. The distal surface **368** is the surface of the distal portion **366** opposite the side of the distal portion that abuts a bone that the guide **302** is mounted to during use, such as a bone **600** of FIG. **14**. The first cutting surfaces **364** of each guiding side **310a** can intersect each other, such as in the embodiment illustrated in FIG. **10**, or the cutting surfaces **364** can be independent of each other. The first cutting surfaces **364** are generally planar and are operable to guide any suitable cutting device to the bone to be cut, such as a human femoral bone **600** of FIG. **14**. The first cutting surfaces **364** can be used to make a number of cuts in the bone **600**, such as chamfer cuts as described below. The second cutting surfaces can be incorporated into any of the other embodiments described herein.

The guide **302** includes second cutting surfaces **370**. The second cutting surfaces **370** are disposed at the end or terminus of each of the first guiding side **310a** and the second guiding side **310b**. The second cutting surfaces **370** are generally planar and generally parallel to the anterior portion **306**. The second cutting surfaces **370** can be used to direct a suitable cutting instrument to the bone to be cut, such as the human femoral bone **600** of FIG. **14**. The second cutting

surfaces 370 can be used to make a number of cuts in the bone 600, such as posterior cuts as described below.

A rim 372 further defines the box-cut shaped opening 312. The rim 372 extends along the portions of the guiding sides 310 and the anterior flange 306 that directly border and define the box-cut shaped opening 312. The rim 372 is raised from or extends from the rest of the guide 302. The rim 372 extends from the guide 302 in a direction opposite to the location of the bone that the guide 302 is attached to when it is in use, as illustrated in FIGS. 14 and 15. The rim 372 has a number of different functions. For example, the rim 372 serves as a guide or stop for the cutting device inserted through the box-cut opening 312 to form the box-cut in the bone 600.

The rim 372 can include one or more slits 374. The slits 374 can be located at a variety of different positions along the rim 372, such as proximate to the first cutting surfaces 364. The slits 374 can take a variety of different shapes and forms. For example, the slits 374 can be elongated or rectangular slits that extend lengthwise between the anterior flange 306 and the second cutting surface 370, as illustrated in FIG. 10. The slits 374 can also be in alignment with each other across the box-shaped opening 312. The slits 374 can be used for a variety of different purposes, such as to receive a removal device to assist in the removal of the guide 302 from the bone being cut.

An aperture 376 extends through each of the first guiding side 310a and the second guiding side 310b. The aperture 376 can take a variety of different forms and can be located at a variety of different locations on the guiding sides 310. For example, the aperture 376 can be located between the first cutting surfaces 364 and extend from an outside surface 378 of each of the guiding sides 310 to a surface of the guiding sides 310 that abuts the bone 600 when the guide 302 is in position on the bone 600. The apertures 376 can be used for a variety of different purposes, such as to receive a fastening device such as a pin or screw, to secure the guide 302 to the bone 600. The apertures 376 can be present in any of the other embodiments described herein.

An additional embodiment of the present invention is illustrated in FIG. 11 at reference numeral 400. Elements common to embodiments 100, 200, and 300 are referenced with numerals having the same second and third digits and prefaced by the digit 4. The above description of the like elements also applies to the apparatus 400.

The guide 402 includes a notch 480. The notch 480 is located in the anterior flange 406 on a side of the anterior flange 406 that abuts the bone 600 when the device is in its operable position about the bone 600 (FIGS. 14 and 15). As illustrated, the notch 480 is in alignment with one of the cutting surfaces 464 of each of the guiding sides 310a and 310b. The notch 480 can be used for a variety of different purposes, such as for a stop or guide for a cutting device inserted through the first cutting surfaces 464.

Extending from the outside surfaces 478 of each of the guiding sides 410 are securing flanges defining apertures 482. The apertures 482 are operable to receive any suitable fastening device capable of securing the guide 402 to the bone being cut with the guide 402. The apertures 482 can be incorporated into any other embodiment described herein. Further, the aperture 376 of the guide 302 can be incorporated into the guide 402.

The guide 402 can further include an aperture 484 that extends through one or both of the guiding sides 410. As illustrated, the aperture 484 is in the region of the first cutting surfaces 464 and extends through the first cutting surfaces 464 from the distal surface 468 completely through the distal portion 466. The aperture 484 is sized to receive any suitable

fastening device capable of securing the guide 402 to bone. The aperture 484 can also be used to attach an augment trial. The aperture 484 can be included in any of the other embodiments described herein.

The second cutting surface 470 of the guide 402 is similar to the second cutting surface 370 of the guide 302. However, the second cutting surface 470 further comprises a posterior flange 486 that is spaced apart from the remainder of each of the guiding sides 410. Therefore, the second cutting surface 470 is not at the terminus of the guiding sides 410, but is between the flange 486 and the remainder of the guiding sides 410.

A first recess 488a and a second recess 488b are formed in the raised rim 472. The recesses 488 are positioned on opposing surfaces of the raised rim 472 in the region of the box-cut shaped opening 312. The recesses 488 are generally parallel to each other and in substantial vertical alignment with each other along the raised rim 472. The recesses 488 extend from the rim 472 to the flange 406. The recesses 488 are formed in a portion of the flange 406 that abuts the bone being cut when the guide is positioned at the bone. The recesses 488 can be of various shapes and sizes, but are generally semi-circular recesses.

The recesses 488 can have a variety of different functions. For example, the recesses 488 provide clearance in the corners of the box-cut shaped opening 312 for a cutting device to assist cutting the bone. The recesses 488 can be included in the other embodiments described herein.

A further embodiment of the present invention is illustrated in FIG. 12 at reference numeral 500. Elements common to embodiments 100, 200, 300, and 400 are referenced with numerals having the same second and third digits and prefaced by the digit 5. The above description of the like elements also applies to the apparatus 500.

The guide 502 includes a first posterior flange 588a and a second posterior flange 588b. The posterior flanges 588 extend from the distal portion 566 at an end opposite the anterior flange 506. The posterior flanges 588 are generally parallel to the anterior flange 506 and are generally perpendicular to the distal portion 566. The posterior flanges 588 can be separate as illustrated in FIG. 12 or can be unitary, such that the posterior flanges 588 take on a configuration similar to the base 108 of the guide 102.

The cutting device receiver or rod 542 extends between the posterior flanges 588. The rod 542 is seated within an opening 590 of each flange 588. The rod 542 can rotate within the openings 590 to any desirable degree depending upon the application. In some applications the rod 542 rotates approximately 90 degrees. The rod 542 includes the center hole 541 and can include, as illustrated, a plurality of the side holes 543. The center hole 541 and the side holes 543 receive the cutting tool 104, as described in the embodiments of guides 102 and 202.

The guide 502 can include any of the features of the other embodiments described herein, as would be understood by one of ordinary skill in the art. For example, the rod 542 can be replaced with the rod 142 of FIG. 3.

A further embodiment of the present invention is illustrated in FIG. 13 at reference numerals 500A and 502A. The guide 502A is substantially similar to the guide 502, except that the guide 502A does not include the guiding side 510a, the posterior flange 588a, or the portion of the anterior flange 506 associated with the guiding side 510a. Essentially, the guide 502A is one-half, the left half, of the guide 502 cut along its sagittal plane. Because the remainder of the guide 502A is substantially similar to the guide 502, elements common to both the guide 502 and the guide 502A are referenced with the

same reference numbers. The description of the common elements provided above in conjunction with the description of the guide **502** also applies to the guide **502A**. While the guide **502A** is illustrated to include the left half of the guide **502**, as cut along its sagittal plane, the orientation of the guide **502A** can be reversed such that in some applications the guide includes the other half, or right half of the guide **502** as cut along its sagittal plane.

The guide **502A** is suitable for use in a variety of different procedures, such as minimally invasive procedures. Any of the other devices **100**, **200**, **300**, and **400** described herein can also be provided with a single guiding side **110**, **210**, **310**, and **410** to make the devices **100**, **200**, **300**, and **400** better suited for use in minimally invasive procedures.

With additional reference to FIGS. **14** and **15**, use of the guide **302** to make resections in a human femoral bone **600** is illustrated. The bone **600** generally includes an anterior surface **602**, a posterior surface **604**, and a distal surface **606**. The guide **302** is positioned at the bone **600** such that the anterior flange **306** is at the anterior surface **602** and the distal portion **366** is at the distal surface **606**. The guide **302** is secured to the bone **600** in any suitable manner. For example, a suitable fastener can be inserted through the aperture **376**, or the aperture **484** if included in the guide **302**, to engage the bone **600** and secure the guide **302** to the bone.

With the guide **302** in position, chamfer cuts **608**, a posterior cut **610**, and a box cut **612** can be made. The cuts **608**, **610**, and **612** can be made in any order depending on the application. Further, not all of the cuts **608**, **610**, and **612** need be made.

The chamfer cuts **608** are made by directing a cutting device, such as a saw, knife, or other sharp edge, to the bone **600** through the first cutting surfaces **364**. The position and orientation of the first cutting surfaces **364** properly aligns the knife at the bone **600** to form the chamfer cuts **608** at a desired position in the bone **600**.

The posterior cut **610** is made by directing a cutting device, such as a knife or sharp edge, to the bone **600** using the second cutting surface **370**. The knife is directed along the second cutting surface **370** to the posterior surface **604** of the bone **600**. The position and orientation of the second cutting surface **370** properly aligns the knife at the bone to form the posterior cuts **610** at a desired position in the bone **600**.

The box cut **612** is made by directing a suitable cutting device, such as a knife, punch, or the rotating mill **104** to the distal surface **606** of the bone **600**. The cutting device is inserted within the box-cut shaped opening **312** and resects the portion of the bone **600** beyond the box-cut shaped opening **312**. The cutting device is directed along the raised rim **372** to define the outer perimeter of the box cut **612**.

After the cuts **608**, **610**, and **612** are made, the guide **302** is removed from the bone **600**. The guide **302** can be removed from the bone **600** in any suitable manner, such as by inserting a removal device through the slits **374** and pulling the guide **302** from the bone.

After the guide **302** is removed, a suitable implant, such as the femoral component **93**, can be secured to the bone. The procedure for securing the femoral component **93** is described above.

The procedures for making the cuts **608**, **610**, and **612** using the guides **402**, **502**, and **502A** is substantially similar to the procedures described above with respect to the guides **102**, **202**, and **302**.

With respect to the guide **502A**, the guide **502A** only overlaps a single condyle, the left condyle, of the femoral bone **600** to make the chamfer cuts **608** and the posterior cut **610** in the left condyle. In embodiments where it is desirable to make

the chamfer cuts **608** and the posterior cut **610** in the right condyle, the guide **502A** having the right guiding side **510a**, as opposed to the left guiding side **510b**, and the right posterior flange **588a**, as opposed to the left posterior flange **588b**, is used.

The various embodiments of the bone-cutting apparatuses described herein provide a convenient cutting tool, which can guide and resect a portion of a bone, such as an intercondylar box portion, for example, quickly and precisely. By providing a pivotable mill, which can also be selectively shifted in a lateral direction, the intercondylar box portion can be removed without the need to apply any impact forces. The bone-cutting apparatus described herein may be an important component of a knee replacement system that includes femoral components **93**, such as those used for posterior stabilized knee prosthesis.

The bone-cutting apparatuses described herein also provide a convenient three-in-one tool for making the chamfer cuts **608**, the posterior cuts **610**, and the box cut **612**. Use of the guides eliminates the need to use a separate device to make each of the cuts **608**, **610**, and **612**. Therefore, the guides save operating time, save costs associated with purchasing additional equipment, and reduce the complexity of preparing a bone to receive an implant.

The description of the invention is merely exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.

What is claimed is:

1. A guide for cutting bone comprising:

- an anterior portion;
- a posterior portion including a first posterior flange and a second posterior flange;
- a distal portion between the anterior portion and the posterior portion, the distal portion including:
 - a distal surface;
 - a first guiding side;
 - a second guiding side spaced apart from the first guiding side; and
 - a plurality of cutting surfaces defined by each of the first guiding side and the second guiding side at an acute angle relative to the distal surface of the first and second guiding sides operable to guide a cutting device to the bone to form chamfer cuts in the bone;
- a box-cut shaped opening defined by the anterior portion, the first guiding side, the second guiding side, the first posterior flange, and the second posterior flange;
- a U-shaped raised rim that extends above an anterior portion of the box-cut shaped opening;
- a cutting tool coupled to the guide, the cutting tool having a longitudinal axis, the cutting tool rotatable about the longitudinal axis, the cutting tool pivotable within the box-cut shaped opening between the posterior portion and the raised rim at the anterior portion of the guide for forming a box cut in the bone; and
- a cylindrical rod extending between the first posterior flange and the second posterior flange, the rod coupled to an end of the cutting tool, the cutting tool selectively movable to a plurality of positions along the rod.

2. The guide of claim 1, wherein the rod defines a plurality of holes having parallel axes, each of the holes operable to receive the cutting tool for selectively moving the cutting tool between the first and second posterior flanges.

11

3. The guide of claim 1, further comprising an aperture at each of the first guiding side and the second guiding side operable to receive a fastening device for securing the guide to the bone.

4. The guide of claim 1, wherein the first guiding side defines two of the cutting surfaces that intersect each other and the second guiding side includes two of the cutting surfaces that intersect each other.

5. The guide of claim 1, wherein the rod is slidable within coaxial first and second bores of the first and second posterior flanges.

6. The guide of claim 5, wherein the rod includes at least one groove at a first end of the rod.

7. The guide of claim 6, wherein the rod includes at least one detent at a second end of the rod, the second end opposite the first end.

8. The guide of claim 7, further comprising a spring-loaded ball plunger coupled to the posterior portion and selectively engaging one of the detents.

9. A guide for cutting bone comprising:

an anterior portion;

a posterior portion including a first posterior flange and a second posterior flange;

a distal portion between the anterior portion and the posterior portion, the distal portion including:

a distal surface;

a first guiding side;

a second guiding side spaced apart from the first guiding side; and

a plurality of cutting surfaces defined by each of the first guiding side and the second guiding side at an acute angle relative to the distal surface of the first and second guiding sides operable to guide a cutting device to the bone to form chamfer cuts in the bone;

a box-cut shaped opening defined by the anterior portion, the first guiding side, the second guiding side, the first posterior flange, and the second posterior flange;

a cutting tool coupled to the guide, the cutting tool having a longitudinal axis, the cutting tool rotatable about the longitudinal axis, the cutting tool pivotable within the box-cut shaped opening between the anterior and posterior portions of the guide for forming a box cut in the bone; and

a rod extending between the first and second posterior flanges, the rod defining a plurality of holes having parallel axes for receiving an end of the cutting tool, such that the cutting tool can be selectively moved to a plurality of positions along the rod.

10. The guide of claim 9, wherein the rod is rotatably received in first and second bores defined in the first and second posterior flanges of the guide.

11. The guide of claim 9, wherein the end of the cutting tool is coupled to one of the holes by a pin.

12

12. The guide of claim 9, further comprising a raised rim that extends about portions of the anterior portion that define the box-cut shaped opening.

13. The guide of claim 9, wherein the first guiding side defines two of the cutting surfaces that intersect each other and the second guiding side includes two of the cutting surfaces that intersect each other.

14. guide for cutting bone comprising:

an anterior portion;

a posterior portion including a first posterior flange and a second posterior flange;

a distal portion between the anterior portion and the posterior portion, the distal portion including:

a distal surface;

a first guiding side;

a second guiding side spaced apart from the first guiding side; and

a plurality of cutting surfaces defined by each of the first guiding side and the second guiding side at an acute angle relative to the distal surface of the first and second guiding sides operable to guide a cutting device to the bone to form chamfer cuts in the bone;

a box-cut shaped opening defined by the anterior portion, the first guiding side, the second guiding side, the first posterior flange, and the second posterior flange;

a cutting tool coupled to the guide, the cutting tool having a longitudinal axis, the cutting tool rotatable about the longitudinal axis, the cutting tool pivotable within the box-cut shaped opening between the anterior and posterior portions of the guide for forming a box cut in the bone; and

a rod extending between the first and second posterior flanges, the rod slidably received within coaxial first and second bores of the first and second posterior flanges, the rod coupled to an end of the cutting tool, such that the cutting tool can be selectively moved to a plurality of positions along a longitudinal axis of the rod.

15. The guide of claim 14, further comprising a raised rim that extends about portions of the anterior portion that define the box-cut shaped opening.

16. The guide of claim 14, wherein the first guiding side defines two of the cutting surfaces that intersect each other and the second guiding side includes two of the cutting surfaces that intersect each other.

17. The guide of claim 14, wherein the rod includes a plurality of grooves at a first end of the rod.

18. The guide of claim 17, wherein the rod includes a plurality of detents at a second end of the rod, the second end opposite the first end.

19. The guide of claim 18, further comprising a pin coupled to the posterior portion, the pin selectively engaging one of the grooves.

20. The guide of claim 19, further comprising a spring-loaded ball plunger selectively engaging one of the detents.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 7,674,268 B2
APPLICATION NO. : 11/265221
DATED : March 9, 2010
INVENTOR(S) : John M. Cuckler et al.

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 3

Line 35, after “according”, insert --to--.

Column 3

Line 55, after “it”, delete “is”.

Column 8

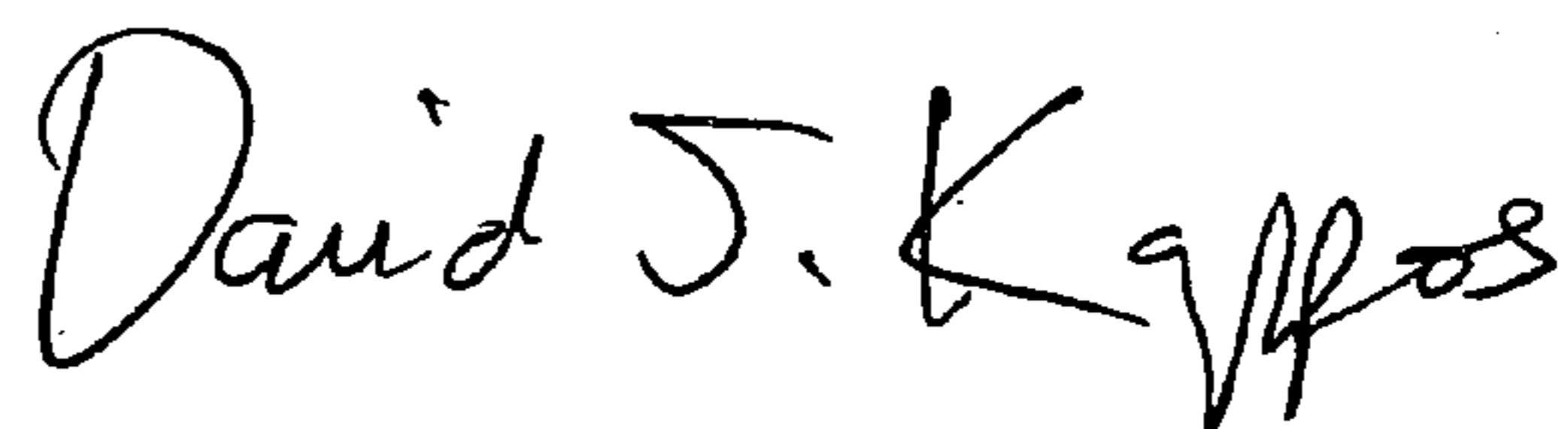
Line 1, “or” should be --of--.

Column 12

Line 8, at beginning of claim 14, insert --A-- before “guide”.

Signed and Sealed this

Twenty-fifth Day of May, 2010



David J. Kappos
Director of the United States Patent and Trademark Office